Volume Three Number Two

SCHOOL OF MINES AND METALLURGY

UNIVERSITY OF MISSOURI

BULLETIN

MARCH, 1911

1910——CATALOGUE——1911

Rolla, Missouri

Entered as second-class matter January 7, 1909, at the post-office at Rolla, Missouri, under the Act of July 18, 1894. Issued Quarterly.

SCHOOL OF MINES AND METALLURGY

UNIVERSITY OF MISSOURI

FORTIETH ANNUAL CATALOGUE

ROLLA, MISSOURI

1911

1911

JANUARY.

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31	..	..	..	..
..	..	..	..	..	..	..

FEBRUARY.

S	M	T	W	T	F	S
..	..	..	1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	..	..	..	..
..	..	..	..	..	..	..

MARCH.

S	M	T	W	T	F	S
..	..	..	1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	..
..	..	..	..	..	..	..

APRIL.

S	M	T	W	T	F	S
..	..	..	..	..	..	1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	..	..	..	..	..	..

MAY.

S	M	T	W	T	F	S
..	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31	..	..	..
..	..	..	..	..	..	..

JUNE.

S	M	T	W	T	F	S
..	..	..	..	1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	..
..	..	..	..	..	..	..

JULY.

S	M	T	W	T	F	S
..	..	..	..	..	..	1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31	..	..	..	..	..

AUGUST.

S	M	T	W	T	F	S
..	..	1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31	..	..
..	..	..	..	..	..	..

SEPTEMBER.

S	M	T	W	T	F	S
..	..	..	..	..	1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
..	..	..	..	..	..	..

OCTOBER.

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31	..	..	..	..
..	..	..	..	..	..	..

NOVEMBER.

S	M	T	W	T	F	S
..	..	..	1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	..	..
..	..	..	..	..	..	..

DECEMBER.

S	M	T	W	T	F	S
..	..	..	..	..	1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31	..	..	..	..	..	..

1912

JANUARY.

S	M	T	W	T	F	S
..	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31	..	..	..
..	..	..	..	..	..	..

FEBRUARY.

S	M	T	W	T	F	S
..	..	..	..	1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	..	..
..	..	..	..	..	..	..

MARCH.

S	M	T	W	T	F	S
..	..	..	..	..	1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31	..	..	..	..	..	..

APRIL.

S	M	T	W	T	F	S
..	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	..	..	..	..
..	..	..	..	..	..	..

MAY.

S	M	T	W	T	F	S
..	..	..	1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	..
..	..	..	..	..	..	..

JUNE.

S	M	T	W	T	F	S
..	..	..	..	..	..	1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	..	..	..	..	..	..

JULY.

S	M	T	W	T	F	S
..	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31	..	..	..
..	..	..	..	..	..	..

AUGUST.

S	M	T	W	T	F	S
..	..	..	..	1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31
..	..	..	..	..	..	..

SEPTEMBER.

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	..	..	..	..	..
..	..	..	..	..	..	..

OCTOBER.

S	M	T	W	T	F	S
..	..	1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31	..	..
..	..	..	..	..	..	..

NOVEMBER.

S	M	T	W	T	F	S
..	..	..	..	..	1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
..	..	..	..	..	..	..

DECEMBER.

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31	..	..	..	..
..	..	..	..	..	..	..

TABLE OF CONTENTS

CALENDAR.

1911

March 11, Saturday..... Registration for Third Term.

March 13, Monday..... Third Term Class Work Begins.

May 26, Friday..... Annual Commencement.

May 29, Monday..... Summer School Begins.

July 8, Saturday..... Summer School Closes.

September 9, Saturday..... Entrance Examinations.

September 11, Monday..... Registration for First Semester.

September 12, Tuesday..... First Semester Class Work Begins.

December 21, Thursday at 4 p. m.... Christmas Recess Begins.

1912

January 19, Friday..... First Semester Ends.

January 20, Saturday..... Registration for Second Semester.

January 22, Monday..... Second Semester Class Work Begins.

February 22, Thursday..... Holiday.

May 31, Friday..... Annual Commencement.

BOARD OF CURATORS.

S. L. Baysinger.....*Rolla, Mo.*

P. E. Burton.....*Joplin, Mo.*

D. R. Francis.....*St. Louis, Mo.*

J. C. Parrish.....*Vandalia, Mo.*

C. B. Rollins.....*Columbia, Mo.*

J. C. Swift.....*Kansas City, Mo.*

T. J. Wornall.....*Liberty, Mo.*

C. E. Yeater.....*Sedalia, Mo.*

G. L. Zwick.....*St. Joseph, Mo.*

OFFICERS OF THE BOARD.

J. V. C. Karnes.....*President.*

D. R. Francis.....*Vice-President.*

J. G. Babb.....*Secretary.*

R. B. Price.....*Treasurer.*

EXECUTIVE COMMITTEE

OF THE

SCHOOL OF MINES AND METALLURGY.

S. L. BAYSINGER.....*Rolla.*

P. E. BURTON.....*Joplin.*

T. J. WORNALL.....*Liberty.*

OFFICERS OF THE COMMITTEE.

S. L. BAYSINGER.....*Chairman.*

EDW. KAHLBAUM.....*Secretary.*

C. M. KNAPP.....*Treasurer.*

Director of the School,

LEWIS E. YOUNG.

Secretary of the Faculty,

JOHN B. SCOTT.

Registrar,

EDW. KAHLBAUM.

Librarian,

IDA STEVENS GARRETT.

Superintendent of Buildings and Grounds,

ROBERT R. DICKERSON.

FACULTY.

ALBERT ROSS HILL, A. B., Ph. D., LL. D.,
President of the University.
A. B., Dalhousie University, 1892; Ph. D., Cornell University, 1895; LL. D., University of South Carolina, 1905; Dalhousie University, 1908; Westminster College, 1909.

LEWIS EMANUEL YOUNG, E. M.,
Director.
B. S. in Mining Engineering, Pennsylvania State College, 1900; E. M., Iowa State College, 1904.

GEORGE REINALD DEAN, C. E.,
Professor of Mathematics.
C. E., School of Mines, 1890; B. S. in Mathematics and Physics, School of Mines, 1891.

AUSTIN LEE McRAE, S. D.,
Professor of Physics.
B. S., University of Georgia, 1881; S. D., Harvard University, 1886.

VICTOR HUGO GOTTSCHALK, M. S.,
Professor of Chemistry.
B. S. in Chemistry and Metallurgy, School of Mines, 1898; M. S., School of Mines, 1900.

ELMO GOLIGHTLY HARRIS, C. E.,
Professor of Civil Engineering.
C. E., University of Virginia, 1882.

DURWARD COPELAND, S. B.,
Professor of Metallurgy.
S. B., Massachusetts Institute of Technology, 1903.

JOSEPH HENRY BOWEN,
Assistant Professor of Shop Work and Drawing.
Graduate, Miller School, Va.

GUY HENRY COX, B. S., M. A.,
Assistant Professor of Geology and Mineralogy.
B. S. in General Science, Northwestern University, 1905; M. A., University of Wisconsin, 1908.

*LEON ELLIS GARRETT, B. S.,
Assistant Professor of Mathematics.
B. S. in General Science, School of Mines, 1901.

CARROLL RALPH FORBES, E. M.,
Assistant Professor of Mining.
B. S., Michigan College of Mines, 1902; E. M., Michigan College of Mines, 1903.

LOUIS AGASSIZ TEST, Ph. D.,
Assistant Professor of Chemistry.
B. M. E., Purdue University, 1894; A. C., Purdue University, 1896; Ph. D., University of Chicago, 1907.

JULIUS WOOSTER EGGLESTON, B. S., A. M.,
Assistant Professor of Geology and Mineralogy.
B. S., Amherst College, 1898; A. M., Harvard University, 1901.

PAUL JULIUS WILKINS, B. S.,
Instructor in Modern Languages,
B. S., Michigan Agricultural and Mechanical College, 1869.

JOHN BENNETT SCOTT, B. S.,
Instructor in English and Secretary.
B. S. in General Science, School of Mines, 1907.

BOYD DUDLEY, JR., B. S., M. S.,
Instructor in Metallurgy and Ore Dressing.
B. S. in General Science, School of Mines, 1908; M. S., School of Mines, 1910.

HORACE THARP MANN, M. S., E. M.,
Instructor in Metallurgy.
B. S. in Mining Engineering, School of Mines, 1908; M. S. in General Science, School of Mines, 1909; E. M., School of Mines, 1910.

*On leave of absence, session 1910-1911.

J. TERRENCE McVEY, C. E.,
Instructor in Civil Engineering.
C. E., Lehigh University, 1906.

FRANK EDWARD DENNIE, B. S.,
Instructor in Physical Training.
B. S. in Civil Engineering, Brown University, 1909.

FREDERICK WILLIAM BUERSTATTE, B. S.,
Instructor in Drawing.
B. S. in Mechanical Engineering, University of Wisconsin, 1901.

MEYER GABA, M. S.,
Instructor in Mathematics.
B. S., University of Chicago, 1907; M. S., University of Chicago, 1908.

VACHEL HARRY McNUTT, B. S.,
Instructor in Mineralogy.
B. S., School of Mines, 1910.

JOHN PERRY WALKER, Jr.
Assistant in Chemistry.

CAIRY C. CONOVER,
Student Assistant in Drawing.

RAYMOND ALEXANDER BINGHAM,
Student Assistant in Physics.

OSCAR ALAN RANDOLPH,
Student Assistant in Chemistry.

ENOCH RAY NEEDLES,
Student Assistant in Surveying.

JAMES EDWARD McGOUGHRAN,
Student Assistant in Chemistry.

ARCH WAUGH NAYLOR,
Student Assistant in Shop Work.

FACULTY COMMITTEES.

Admission.

Professors Dean, Wilkins, and Scott.

Athletics.

Professors Bowen, Copeland, Test, and Cox.

Buildings, Plant, and Grounds.

Professors McRae and Harris.

Degrees.

Professors McRae, Scott, and Dean.

Examinations and Schedule.

Professors Forbes, Bowen, and Dudley.

Graduate Courses.

Professors Gottschalk and Copeland.

Publications.

Professors Cox, Test, and Scott.

Student Council.

Professors Copeland, McRae, Cox, Forbes, and Mr. Dennie.

Theses.

Professors Harris, Copeland, Cox, and Forbes.

Undergraduate Courses.

Professors Dean, McRae, Cox, and Gottschalk.

HISTORY OF THE SCHOOL.

In 1870 the General Assembly of Missouri, in accepting the donation of land for educational purposes made by the General Government through an Act of Congress, approved July 2, 1862, established an Agricultural and Mechanical College and a School of Mines and Metallurgy. The design of these institutions is set forth in the following language:

"Objects of These Colleges.—The leading objects of said colleges shall be to teach such branches as are related to agriculture and mining." (Revised Statutes, 1909, Section 11134.)

The School of Mines and Metallurgy was located at Rolla, Phelps County. Here, in November, 1871, the school was formally opened. The statutes fix the status of the school as one of the Colleges of the State University. Its affairs are under the immediate supervision of an Executive Committee, consisting of three members of the University Board of Curators, selected by that body. The need of general culture as a foundation and accompaniment of specifically technical training led to the establishment, in 1885, of an Academic Course in compliance with the following Act of the General Assembly:

"Academic Course of Study, Etc.—That the obligation of the State to the General Government, assumed by the acceptance of the land grant of July 2d, 1862, may be more fully discharged, and in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions of life, the Board of Curators of the University of the State of Missouri shall prescribe and adopt a liberal academic course of study to be taught in the School of Mines and Metallurgy located at Rolla, in addition to the courses now taught in said school, and may confer the degree of bachelor of science upon all students who shall complete said course in said school to the satisfaction of the faculty thereof." (Revised Statutes, 1909, Section 11135.)

ROLLA BUILDING

FINANCES.

The proceeds from the sale of the public lands granted by the General Government amount to about $350,000, which is invested in State certificates of indebtedness bearing 5 per cent interest. The School of Mines receives one-fourth of the yearly income thus accruing.

By an Act of Congress, approved August 30, 1890, commonly known as the "Morrill Bill," the General Government assists each State and Territory in maintaining a college or colleges in accordance with the act of July 2, 1862. After deducting one-sixteenth for the Lincoln Institute, Missouri gives one-fourth of the remainder of this fund to the School of Mines.

In 1891 the Government returned to the various States the sums collected from their citizens by the imposition during the Civil War of a "direct tax." The amount thus refunded to Missouri was $646,958.23, and the Thirty-sixth General Assembly of the State won the gratitude of the friends of higher education by establishing this as a permanent endowment for the State University at Columbia and the School of Mines and Metallurgy at Rolla. One-fifth of the income from this endowment is received by the School of Mines.

The Fortieth General Assembly of the State passed an act providing for a tax on collateral inheritances for the benefit of the State University, and the Forty-first General Assembly provided that one-fifth of the funds derived from this tax shall be appropriated for the benefit of the School of Mines.

ENDOWMENT.

The State endowment of the School of Mines is set forth in the following extracts from the Statutes of Missouri:

"The proceeds of the sale of lands donated to the State of Missouri by the United States for the support of the College of Agriculture and Mechanic Arts and the School of Mines and Metallurgy, by Act of Congress, approved July 2, 1862, represented by State certificates of indebtedness, of the following amounts and dates:

July 2, 1883	$242,000.00
November 1, 1883	5,000.00
January 29, 1884	5,000.00
April 19, 1884	35,000.00
April 2, 1885	5,000.00
February 25, 1886	5,000.00
January 1, 1888	5,000.00
December 15, 1888	5,000.00
May 15, 1889	5,000.00
July 1, 1891	5,000.00
May 15, 1893	5,000.00
July 1, 1895	22,881.19
April 9, 1895	5,000.00
Representing a total of	$349,881.19

Now issued or any certificates which may hereafter be issued under any general or special act of the General Assembly; one-fourth of the interest of these funds shall be paid to the Treasurer of the School of Mines and Metallurgy, at Rolla, for the maintenance of said institution."

"The proceeds of sales of lands donated to the School of Mines and Metallurgy, at Rolla, represented by the State certificate of indebtedness of $2,000, dated April 15, 1893, issued under act March 31, 1883, interest on which shall be applied to the maintenance of the School of Mines and Metallurgy, at Rolla."

"The State certificate of indebtedness of $3,000, issued under act of April 1, 1895, dated April 1, 1896, four-fifths of the interest to be applied to the maintenance of the State University, at Colum-

bia, and one-fifth to the School of Mines and Metallurgy, at Rolla, and also any other certificates which may hereafter be issued and held in trust for this fund under any general or special act of the General Assembly." (Revised Statutes, 1909, Section 11161.)

"The State certificate of indebtedness of $646,958.23, derived from 'direct tax' received from the United States, dated April 1, 1891, issued under act of March 26, 1891, four-fifths of the interest to be applied for the maintenance of the State University, at Columbia, and one-fifth for the School of Mines and Metallurgy, at Rolla." (Revised Statutes, 1909, Section 11161.)

"All sums collected under the provisions of an Act of Congress, approved August 30, 1890, commonly known as the 'Morrill Bill,' shall be paid as follows: One-sixteenth thereof for the benefit of the Lincoln Institute and one-fourth of the remainder to the Treasurer of the School of Mines, at Rolla, Missouri." (Revised Statutes, 1909, Section 11171.)

Collateral Inheritance Tax.—"The moneys received by the State Treasurer under the provisions of this article shall be deposited in the State Treasury to the credit of the fund now existing in the State Treasury, and known as the 'State Seminary Moneys,' for the maintenance, support and better equipment of the buildings, apparatus, books, instruction, etc., of the University of the State of Missouri, to an amount not exceeding in any one year the equivalent of one-tenth of one mill for every dollar of the assessed valuation of taxable property of the State for the said year; *Provided*, that one-fifth of all such moneys so received shall be devoted to the use of the School of Mines and Metallurgy, a department of the said University." (Revised Statutes, 1909, Section 312.)

LOCATION.

The School of Mines is located at Rolla, the county seat of Phelps County, on the St. Louis and San Francisco Railroad, approximately halfway between St. Louis and Springfield.

Rolla is on the crest of the Ozark uplift, at an elevation of eleven hundred forty feet above the sea level, and has an agreeable and notably healthful climate. Its position on a great transcontinental railway system makes it readily accessible.

The school is within easy reach of the important mining districts of the State, which offer splendid facilities for the study of mining geology, mining methods, ore dressing, and mining machinery. Numerous recent improvements, due to the systematic study of Missouri ore deposits, methods of ore treatment, and the extensive development of low-grade lead and zinc ores, have given the school advantages for the application of the theories of geology, mining, and ore dressing to practice.

The smelting industry of the State is very important and every courtesy is extended to the professors and students of the school during their visits to these metallurgical plants. The methods of mining coal and clay can be readily studied in Missouri and the adjoining fields. Numerous clay-working and cement plants in St. Louis and the vicinity offer good opportunity for the study of these important industries. In and about St. Louis are also various chemical plants which are visited from time to time.

CAMPUS AND ATHLETIC FIELD.

The grounds of the School of Mines are situated in the highest part of the City of Rolla, and are over twenty-seven acres in extent. The campus contains beautiful lawns, groves of native oak, and many shade trees.

The Jackling Field has a good baseball diamond, a football gridiron, tennis courts, and a 440-yard running-track. On the athletic field there is a suitable building providing shower baths and a dressing room for the various athletic teams.

VIEW ON THE CAMPUS

BUILDINGS.

Rolla Building.

This building was originally built by the City of Rolla as a High School building, but was sold to the State in 1871, and for many years was the principal building of the School of Mines and Metallurgy. It is a brick structure, ninety feet by sixty feet, four stories high, including a working basement. It contains the library, laboratories, drafting rooms, offices, and geological collections of the State Geological Survey, recitation rooms for mathematics and modern languages, toilet, shower baths, and locker rooms.

Chemical Hall.

The main portion of this building was erected in 1885 and two wings were added in 1902. The main building is two stories high and one hundred two feet in length by fifty-five feet in width. Each wing is fifty-five feet by sixty feet and one story high. This entire building, including a large basement, is used for chemistry.

Mining Building and Power Plant.

This building, erected in 1895, is a tile-roof, press-brick structure, and consists of two distinct portions, one containing offices, an instrument room, and laboratories—the other comprising a large mining laboratory, an engine room, and a boiler room.

Mechanical Hall.

This two-story brick building, erected in 1901, is one hundred fifty feet by sixty feet and was specially designed for mechanical work. The second floor includes a demonstration lecture room, a shop for bench-work in wood, and a temporary gymnasium. The first floor contains a lathe room for wood-turning, a forge room, a metal-working room, and a stock and tool room.

Each floor is provided with a lavatory and lockers, and an office for the instructor.

Norwood Hall.

The corner stone of this building was laid November 23, 1902, and the building was first used in 1903. It contains adequate quarters for the demonstration offices, and provides lecture and recitation rooms for physics, geology, mineralogy, civil engineering, English, mathematics; also drawing rooms and laboratories for physics, geology, mineralogy, and civil engineering. The school library is located on the first floor of Norwood Hall.

Ore Dressing Building.

This is a three-story gray press-brick building with a basement and two large one-story wings. Two stories and the west wing have been in use since January, 1908, and the east wing was erected in 1909. The building provides quarters for metallurgy and ore dressing.

Director's Residence.

This is a two-story brick and frame building, erected in 1889 and used for a number of years as a student club-house and dormitory.

Athletic Building.

A one-story frame building, thirty-seven by thirty-four feet, formerly used as a wood shop, is now used by the athletic teams and provides dressing rooms, lavatory, and store room for athletic supplies.

Carpenter Shop.

The general repair work of the school and construction of laboratory equipment is carried on in a frame building, one hundred fifty feet by twenty-two feet. This building is located west of Mechanical Hall and includes a store room for lumber.

LIBRARY.

The Library contains ten thousand five hundred carefully selected volumes and several thousand pamphlets and bulletins. Good collections of works on engineering, mathematics, chemistry, physics, mining, metallurgy, ore dressing, geology, and mineralogy afford to students an opportunity to pursue an extended course of reading in connection with their class-work. The Library also contains the standard works in English and American poetry, fiction, biography, and history. It is well provided with encyclopedias and works for general reference. All of the important technical periodicals and reports are received regularly, together with general magazines which are of interest to engineers and scientists.

Current and recent technical literature plays such an important part in present-day education that an elaborate card index to technical literature has been provided and is maintained up to date. More than 45,000 important articles in transactions of societies, reports, bulletins, and periodicals have been recorded and classified.

The Library is the depository for the maps, drawings, photographs, and lantern slides. A splendid series of several thousand photographs of Missouri mines, mills, and smelters is on file and indexed so that it is easily accessible. Photographs have been secured, from most of the important mining camps, of the work, and the student may supplement the daily lectures by reference to these selected illustrations.

The valuable collection of nearly three thousand maps and drawings is indexed and is used to supplement work in the class room and in the drafting room.

The library is open from 9 A. M. until noon, from 1 P. M. to 5 P. M., and from 7 P. M. to 9 P. M. daily except Sunday.

ADMISSION.

Under the statutes persons of either sex, sixteen years of age or over, whether residents of Missouri or not, may be admitted upon evidence of sufficient preparation. Students should have a good liberal education, its elements at least, before beginning technical study. The average age of members of the present Freshman class at entrance was about eighteen years. Specific requirements have been fixed by considerations of the express design of the school—"to promote the education of the industrial classes" in certain branches of engineering—and for the educational opportunities of its intended beneficiaries. The requirements for admission to the Freshman class are as follows:

The applicant must file with the Director a satisfactory certificate of good moral standing.

Admission by Examination.—Applicants for admission, not having diplomas from approved schools, are required to pass examinations in fifteen units, a unit being the equivalent of a year's work in one subject, as given in an approved high school.

Of these fifteen units the following are required: Three units in English, one and one-half units in Algebra, one unit in Plane Geometry, and one-half unit in Solid Geometry. The remaining nine units may be selected from the following list:

Subject.	Maximum.	Minimum.
English	4	3
Algebra	1½	1½
Plane Geometry	1	1
Solid Geometry	½	½
Trigonometry	1	½
History	4	1
Civil Government	½	½
Latin	4	2
Greek	3	2
German	3	2
French	3	2
Spanish	3	2
Physics	2	1
Chemistry	2	1
General Biology	2	1

Subject.	Maximum.	Minimum.
Zoology	2	1
Botany	2	1
†Physiology	1	1
Physical Geography	1	1
Drawing	2	1
*Manual Training	2	1
*Economics	½	½
*Commercial Geography	½	½
*Bookkeeping	1	1

MATHEMATICS. (4 UNITS.)

The four units which may be offered in mathematics are as follows:

ALGEBRA. (1½ Units.) Elementary algebra, including the elementary operations, solution of simple and simultaneous linear equations, factoring, radicals, exponents, quadratic equations, equations containing radicals, imaginaries, simultaneous quadratics, higher equations solved as quadratics, relations of roots and coefficients of quadratics and higher numerical equations, solution of higher equations by factoring, Horner's method of approximation, binomial theorem for positive integral exponent, ratio and proportion, and logarithms.

While the study of these particular subjects is recommended, it is not expected that the student shall be able to pass an examination on each and every one of them. He must produce evidence, however, of having studied algebra for one and one-half years under a good teacher in an accredited high school.

PLANE GEOMETRY. (1 Unit.) The work in Plane Geometry must cover a full year in any good text. It is recommended that considerable attention be paid to the applications of the algebra to geometry, and of geometry to algebra and arithmetic.

SOLID GEOMETRY. (½ Unit.) A full half-year's work is required in Solid Geometry. The same recommendations apply here as in Plane Geometry, with the additional requirement that the student be drilled in arithmetical work in computing areas and volumes.

TRIGONOMETRY. (1 Unit.) It is to be understood at the outset that this work will not be accepted for advanced standing. This branch of mathematics is of such great importance to the practical

†In cases where the study of Physiology has been preceded by a year's study of Biology.

*The maximum amount of commercial and industrial subjects accepted is four units.

engineer that the whole subject must be reviewed, and the student led to a point of view which it is impossible to attain in a high school course.

ENGLISH. (4 Units.)

The four units that may be offered in English include grammar, composition and rhetoric, and literature.

The candidate will be required to show a reasonable proficiency in the principles of English grammar, including sentence-analysis. He will be required to show the ability to express himself coherently and correctly, with a fair mastery of the forms of writing, spelling and punctuation, sentence and paragraph structure. He will be examined on the literature listed below, and, if he desires four units, will be required to show also a knowledge of the history of English literature.

The classics prescribed are as follows:

I. For Study and Practice. Shakespeare's *Macbeth;* Milton's *Lycidas, Comus, L'Allegro* and *Il Penseroso;* Burke's *Speech on Conciliation* or Washington's *Farewell Address*, and Webster's *First Bunker Hill Oration;* Macaulay's *Life of Johnson* or Carlyle's *Essay on Burns.*

II. For Reading. Group 1 (two to be selected): Shakespeare's *As You Like It; Henry V.; Julius Caesar; The Merchant of Venice; Twelfth Night.*

Group 2 (one to be selected): Bacon's *Essays;* Bunyan's *The Pilgrim's Progress*, Part I.; Addison's *Sir Roger de Coverley;* Franklin's *Autobiography.*

Group 3 (one to be selected): Chaucer's *Prologue;* Spenser's *Faerie Queene* (Selections); Pope's *The Rape of the Lock;* Goldsmith's *The Deserted Village;* Palgrave's *Golden Treasury* (First Series), Books II. and III., with especial attention to Dryden, Collins, Gray, Cowper, and Burns.

Group 4 (two to be selected): Goldsmith's *The Vicar of Wakefield;* Scott's *Ivanhoe;* Scott's *Quentin Durward;* Hawthorne's *House of the Seven Gables;* Thackeray's *Henry Esmond;* Mrs. Gaskell's *Cranford;* Dickens' *A Tale of Two Cities;* George Eliot's *Silas Marner;* Blackmore's *Lorna Doone.*

Group 5 (two to be selected): Irving's *Sketch Book* (Selections); Lamb's *Essays of Elia;* DeQuincey's *Joan of Arc* and *The English Mail Coach;* Carlyle's *Heroes and Hero Worship;* Emerson's *Essays* (Selected); Ruskin's *Sesame and Lilies.*

Group 6 (two to be selected): Coleridge's *The Ancient Mariner;* Scott's *The Lady of the Lake;* Byron's *Mazeppa* and *The Prisoner of Chillon;* Palgrave's *Golden Treasury* (First Series), Book IV., with

especial attention to Wordsworth, Keats, and Shelley; Macaulay's *Lays of Ancient Rome;* Poe's *Poems;* Lowell's *The Vision of Sir Launfal;* Arnold's *Sohrab and Rustum;* Longfellow's *The Courtship of Miles Standish;* Tennyson's *Lancelot and Elaine, The Passing of Arthur, Gareth and Lynette;* Browning's *Cavalier Tunes, The Lost Leader, How They Brought the Good News from Ghent to Aix, Evelyn Hope, Home Thoughts from Abroad, Home Thoughts from the Sea, Incident of the French Camp, The Boy and the Angel, One Word More, Herve Riel, Pheidippides.*

HISTORY.

Four units may be offered in history; one each in Ancient History, Medieval and Modern History, English History, and American History.

Civil Government. One-half unit may be offered in Civil Government. This is the equivalent of one-half year's work in the fourth year of a high school and the applicant should have a knowledge of the chief organs of local, state, and national government, and a knowledge of the historical development of the government.

PHYSIOGRAPHY.

A student may offer one unit in physiography. A description of this unit will be sent on request.

PHYSICS.

The two units that may be offered in physics are as follows:

1. A year's work, five periods per week, of which at least two must be double periods in individual laboratory work. At least thirty-five exercises, selected from a list of sixty or more, equivalent to those recommended by the National Educational Association, must be completed.

2. A continuation of the laboratory for another year, or a year's work in a more advanced text together with the laboratory work.

Laboratory note-books must be presented by those who are required to take the entrance examination.

DRAWING.

Two units may be offered.

The following outline recently adopted by the North Central Association of Colleges and Secondary Schools, indicates the nature of the work which should be included in the two units of drawing. While the work is not separated here, into a first and second year program, the more elementary forms of each phase of the subject should be selected for the first year.

a. Pictorial. Plant study (flowers, sprays of leaves, seed, pods,

etc.). Object study (elementary perspective). Landscape (roof studies, buildings, etc., elementary perspective). Pose Drawing.

b. Decorative Composition. Plant forms, object study, landscape pose.

c. Decorative Design. Plant analysis (for the purpose of design). Decorative units, borders, surfaces, corners, rosettes, posters, book-covers, etc. Arrangement of straight lines, and of straight and curved lines. Geometric design. Lettering (printing).

d. Constructive Design. Designs for pottery, leather, cardboard, construction, etc.

e. Crafts. Pottery, leather (choice of one).

f. Applied Design. Design applied to cardboard, textiles, etc.

g. Instrumental Drawing such as is needed to meet the requirements of practical designing and construction.

The candidate should have some knowledge of the history of the industry and art, and some knowledge of civic planning, domestic architecture and decoration.

NOTE.—Mediums used are pencil, charcoal, water color, crayons, brush and ink, and a combination of the pure mediums.

MANUAL TRAINING.

Two units in manual training may be offered. One unit should be in Bench Work and one in Mechanical Drawing. The time required in each of these subjects is five double periods for one year or five single priods for two years. Where conditions permit it is generally advisable to give these subjects as parallel courses.

LATIN.

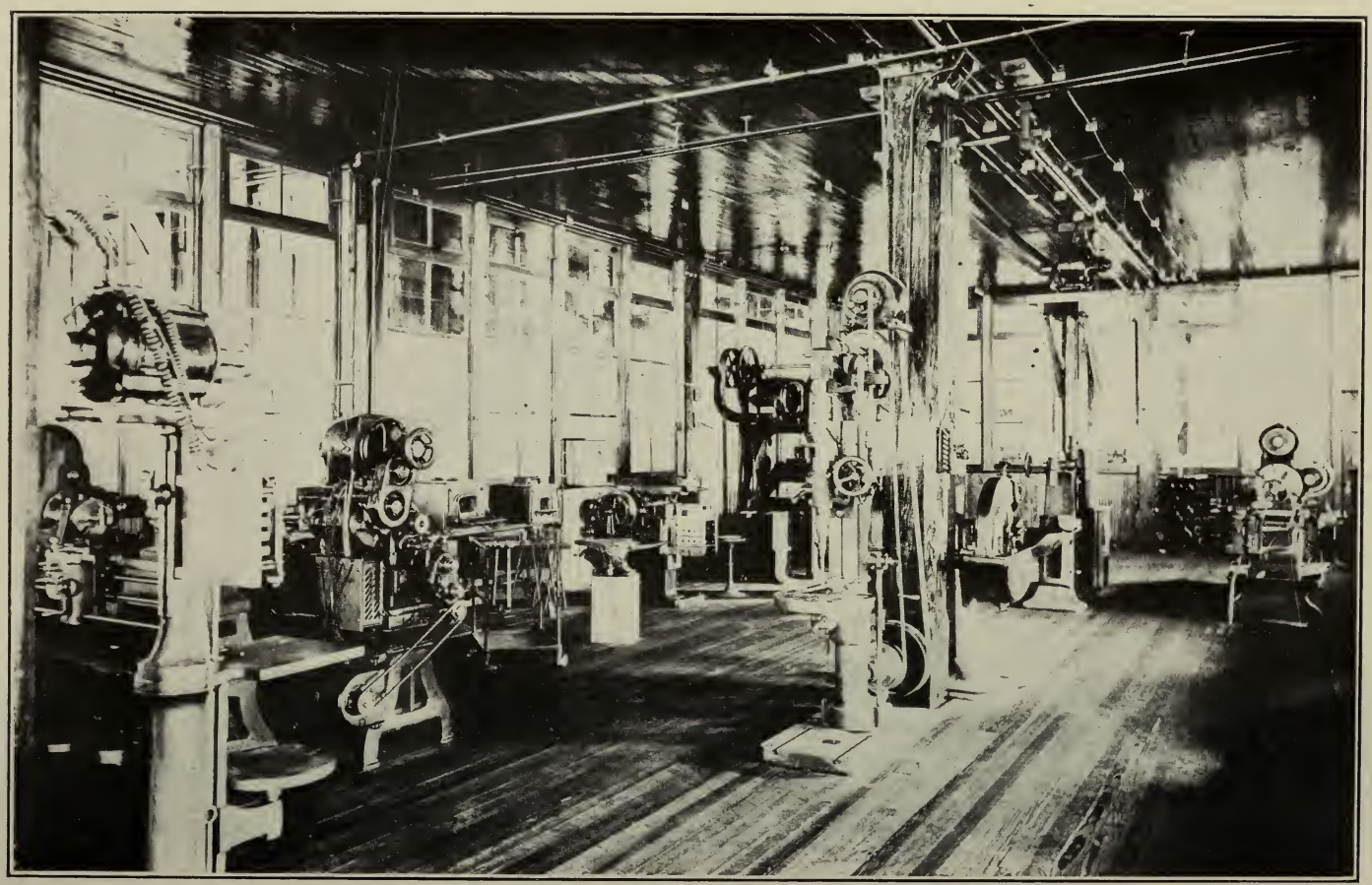
The four units that may be offered in Latin are as follows:

1. Collar and Daniell's First Latin Book, or the equivalent.

2. Three books of Caesar's Gallic War with composition based thereon in Moulton and Collar's Preparatory Latin Composition or in Daniell's New Latin Composition. For one book of the Gallic War the equivalent in time of Viri Romae, Nepos, or Eutropius may be offered.

3. Two additional books of the Gallic War and four Orations of Cicero with compositions based thereon in the books mentioned above.

4. Ovid's Metamorphoses (2,000 lines) and four books of Virgil's Aeneid, with prosody.



MACHINE SHOP

GREEK.

The three units that may be offered in Greek are as follows:

1. Ball's Elements of Greek, or White's First Greek Book.

2. Four books of Xenophon's Anabasis, Pearson's Greek Prose Composition, or its equivalent, Goodwin's Greek Grammar.

3. Ten Orations of Lysias and the first four books of Homer's Odyssey, or an equivalent amount of other Greek authors. Bridgman's Parallel Exercises based on Lysias.

GERMAN, FRENCH, SPANISH.

Three units may be offered in German, French, or Spanish. A description of the units will be sent on request.

CHEMISTRY.

The two units that may be offered in chemistry are as follows:

1. A year's work in chemistry, five periods per week, of which at least two must comprise laboratory work.

2. A second year's work in the subject, five periods per week, of which at least two must be laboratory work.

Note-books showing work done must be presented by those who are required to take the entrance examinations.

These courses will be accepted for admission, but not for advanced standing.

BOOKKEEPING.

One unit may be offered.

The student should become familiar with the meaning of double entry terms, with rules for debit and credit, and the kinds and uses of books. He should acquire the ability to keep a double entry and a single entry set of books. Furthermore, he should become familiar with such standard business forms as bills, receipts, checks, notes, time and sight drafts, endorsements, invoices, accounts, sales, deposit tickets, express receipts, bills of lading, statements of account, balance sheets, etc. He should become familiar also with the forms of business letters, beginnings and endings, etc., and should know how to write and answer telegrams and advertisements.

Bookkeeping should be done largely under the eye of the teacher as laboratory work. Good penmanship, neatness in work, accuracy and speed must be acquired in such laboratory practice. The exercises in some of the texts which are offered by the various publishers on first lessons or elementary principles would naturally form the basis for much of such work, unless the teacher prepares his own exercise work according to a similar plan. The best evidence of good work in this subject is the character of exercise work which the student can present as a result of his laboratory practice.

Some of the best reference works, useful especially to the teacher in charge of elementary work, are Sprague's *Philosophy of Accounts*, Hatfield's *Modern Accounting*, Lisle's *Accounting in Theory and Practice*, Dicksee's *Bookkeeping for Accounting Students*, and Cole's *Accounts—Their Construction and Interpretation.*

COMMERCIAL GEOGRAPHY.

One-half unit may be offered.

The object of this course is to discover the causes of the present territorial distribution of industries and of the location of lines of communication and transportation. It should treat in detail with reference to the United States, and in less detail with reference to the outlying possessions of the United States and to the most important commercial countries, the following topics: (1) the effect of surface, soil, climate, etc., that is, the physical factor in commerce: (2) the influence of race, religion, education, commercial policies, etc.; that is, the human factor in commerce; (3) the effect of economic forces on production and commerce; (4) means of transportation and communication. The text-book should be supplemented by map work and assigned readings. The census of manufactures in the United States and other countries would form a valuable reference library, both for the purpose of map work and assigned readings.

It is desirable that for purposes of illustration, samples of commercial staples, lantern slides, stereopticon pictures, etc., should be freely employed; and wherever possible, that visits of inspection be made and informal lectures secured by experts in various industries. Commercial Geography should be preceded by Physical Geography, in case both are given.

Admission on Diploma.—Applicants may be admitted upon certificate from a college, high school, or preparatory school when the Faculty is satisfied that the work certified to covers the requirements of the School of Mines and Metallurgy.

Each applicant must file with his diploma a statement, on a School of Mines and Metallurgy blank, from his superintendent or principal, showing that the applicant has to his credit fifteen units.

Following is a list of schools whose courses have been approved by the University, and whose diplomas will admit to the Freshman class without examination.

ACCREDITED SCHOOLS.

Albany High School
Alton (Ill.) High School
Appleton City Academy
Aurora High School
Bartlesville (Okla.) High School
Belton High School
Bethany High School
Bevier High School
Blees Military Academy, Macon
Bloomfield High School
Bolivar High School
Bonne Terre High School
Boonville High School
Braymer High School
Breckinridge High School
Brookfield High School
Brunswick High School
Butler High School
Cainsville High School
Cairo (Ill.) High School
California High School
Cameron High School
Campbell High School
Carleton College
Carrollton High School
Carterville High School
Carthage High School
Caruthersville High School
Centralia High School
Charleston High School
Chillicothe High School
Christian College
Clinton High School
Columbia High School
Cottey College (Nev.)
Covington (Ind.) High School
Culver (Ind.)) High School
Davenport (Ia.) High School
De Soto High School
Dexter High School
Doniphan High School
East St. Louis (Ill.) High School
Eldon High School
Elmwood Seminary
Enid (Okla.) High School
Excelsior Springs High School
Farmington High School
Fayette High School
Ferguson High School
Flat River High School
Fort Scott (Kan.) High School
Fort Smith (Ark.) High School
Fredericktown High School
Fulton High School
Gallatin High School
Grant City High School
Greenfield High School
Greenville (Miss.) High School
Guthrie (Okla.) High School
Hamilton High School
Hannibal High School
Hardin College, Mexico
Harrisonville High School
Higginsville High School
Holden High School
Hopkins High School
Hot Springs (Ark.) High School
Huntsville High School
Iberia Academy
Independence High School
Jackson High School
Jackson Military Academy
Jefferson City High School
Joplin High School
Kahoka High School
Kansas City Central High School
Kansas City Manual Training School
Kemper Military Academy, Boonville
Kennett High School
Keokuk (Ia.) High School

Kewanee (Ill.) High School
Keytesville High School
Kidder Institute
King City High School
Kirksville High School
Kirkwood High School
Knobnoster High School
Lamar High School
Lancaster High School
Leavenworth (Kan.) High School
Lebanon High School
Lee's Summit High School
Lexington High School
Liberty High School
Linneus High School
Lockwood High School
Logan County High School (Guthrie, Okla.)
Louisiana High School
McAlester (Okla.) High School
Macon High School
Maitland High School
Malden High School
Marionville Collegiate Institute
Marshall High School
Maryville High School
Memphis High School
Mexico High School
Missouri Wesleyan College
Moberly High School
Monett High School
Monroe City High School
Montgomery City High School
Mound City High School
Mt. Vernon High School
Muskogee (Okla.) High School
Neosho High School
Nevada High School
New London High School
New Madrid High School
Norborne High School
Odessa High School
Oklahoma City (Okla.) High School
Okmulgee (Okla.) High School
Oregon High School
Palmyra High School
Paola (Kan.) High School
Paris High School
Pawnee (Okla.) High School
Pierce City High School
Pine Bluff (Ark.) High School
Plattsburg High School
Pleasant Hill High School
Poplar Bluff High School
Princeton High School
Quincy (Ill.) High School
Rich Hill High School
Richmond High School
Ridgeway High School
Rock Port High School
Rolla High School
St. Charles High School
St. Charles Military Academy
St. Joseph High School
St. Louis Central High School
St. Louis McKinley High School
St. Louis Manual Training School
St. Louis Yeatman High School
Salisbury High School
Savannah High School
Sedalia High School
Shelbina High School
Shelbyville High School
Shreveport (La.) High School
Sikeston High School
Slater High School
Smith Academy
Springfield High School
Steelville High School
Sweet Springs High School
Synodical College, Fulton
Tarkio High School
Tipton High School
Trenton High School
Troy High School
Tulsa (Okla.) High School
Unionville High School
University High School
University Military School (Mobile, Ala.)
University Preparatory School (Tonkawa, Okla.)
Van Buren (Ark.) High School

Vandalia High School
Walther College, St. Louis
Warrensburg High School
Washington High School
Webb City High School
Webster Groves High School
Wellston Station High School, St. Louis
Wellsville High School
Wentworth Military Academy, Lexington
West Plains High School
Western Military Academy
Westport High School
Windsor High School

Advanced Standing.—Candidates may be admitted to advanced standing either upon examination in the subjects of the previous year or years, or upon certificate from another institution of work accomplished, which is, in the estimation of the Faculty, equivalent to that completed here by the class into which entrance is sought. Applicants for advanced standing should communicate with the Director as early as possible, and all claims for advanced standing, in order to receive recognition, must be made by the student within one term after entrance.

Special Students.—Special students may be admitted without passing the regular examinations required for entrance, under the following conditions: 1. They must be at least twenty-one years of age. 2. They must show good reasons for not taking a regular course. 3. They must pass such examinations or other tests as shall demonstrate fitness to pursue profitably all the subjects selected by them. 4. They shall not be candidates for a degree. 5. Special students are expected to do particularly good work in the subjects which they choose. If, at any period of the session, their work becomes unsatisfactory, their connection with the school will be severed. When the work is chiefly of a laboratory nature they will be required to take at the same time as much class-room work as the Faculty may designate for each particular case.

Since there are many persons who would profit by the opportunities for education offered at the school, but who are unable, through lack of time or preliminary training, to undertake the work of the regular course, the Faculty has made the above provision. In this way it hopes to broaden the usefulness of the school, and to enable it to fulfill its purpose in as liberal a manner as possible.

CURRICULA.

It is the object of the instruction at this institution, first, to lay a broad and solid foundation by acquaintance with principles and theory, and to supplement this, wherever possible, by the discipline of practical application in the laboratory and field. Lectures and recitations are arranged for the morning hours, leaving the afternoon for laboratory and field work. The practical work is designed to illustrate and impress principles, to familiarize the student with the use of instruments with which he is to be concerned in the work of his profession, and to afford an opportunity for original investigation. What is taught orally in the lecture room is applied and illustrated in the laboratory.

The courses are the same in the Freshman year, and differ but slightly in the Sophomore year. The student has thus an opportunity to defer his choice of a specialty until he has spent some time in technical study, and can better estimate his inclinations and capacities.

One hour is given to each recitation or lecture period. The afternoon periods are given to drawing, laboratory and field work, and are of three hours' duration.

The School of Mines and Metallurgy offers four undergraduate curricula with two options in the Senior year and three graduate curricula as follows:

I. Mine Engineering, leading to the degree of Bachelor of Science in Mine Engineering. This is a general course in Mine Engineering having in view all the operations in connection with mining from the prospecting to the delivery of the finished product on the market.

II. Coal Mining Option in Mine Engineering, leading to the degree of Bachelor of Science in Mine Engineering. The first three years of this curriculum are the same as in I., but in the Senior year a group of studies are considered, particularly coal mining methods, in place of the general work in Mine Engineering as given in I.

III. Mining Geology Option in Mine Engineering, leading to the degree of Bachelor of Science in Mine Engineering. The first three years of this curriculum are the same as in I., and in the fourth year the curriculum includes more geology and field work than the general Mine Engineering courses.

IV. Metallurgy, leading to the degree of Bachelor of Science in Metallurgy. This curriculum contemplates especially processes in Metallurgy subsequent to the delivery of ore above ground. It fits a man for positions in connection with concentrating plants and smelters and various branches of industrial chemistry.

V. Civil Engineering, leading to the degree of Bachelor of Science in Civil Engineering. This is a curriculum in engineering as applied especially to railways, highways, and municipal works.

VI. General Science, leading to the degree of Bachelor of Science in General Science. This curriculum is largely elective and provides for a liberal education in science.

VII. Graduate Curriculum in Mine Engineering, leading to the degree of Engineer of Mines. This curriculum is open to Bachelors of Science in Mine Engineering.

VIII. Graduate Curriculum in Metallurgy, leading to the degree of Metallurgical Engineer. This curriculum is open to Bachelors of Science in Metallurgy.

IX. Graduate Curriculum for Engineers, leading to the degree of Engineer of Mines. This curriculum is open to Bachelors of Science in Civil, Electrical, or Mechanical Engineering.

GRADUATE COURSES.

The School of Mines offers graduate work in Mining Engineering, Metallurgy, Ore Dressing, Geology, Economic Geology, Petrography, and Advanced Chemistry. The attention of graduates of engineering schools and of mining schools is directed to the following courses:

Mine Management
Mining Machinery
Mining Machinery Laboratory
Mining Law
Mine Examination and Reports
Mine Plant
Mine Plant Design
Mining Economics
Economic Geology
Geology of the United States
Structural and Metamorphic Geology
Petrography
Petrography Laboratory
Cement and Concrete Structures
Compressed Air
Compressed Air Laboratory
Engineering Designs
Ore Dressing Laboratory
Ore Dressing Problems
Ore Supply
Metallurgy Organization
Metallography
Constitution of Alloys
Metallurgical Problems
Metallurgical Plant
Metallurgical Plant Design
Cyaniding
Electro-Metallurgy
Electro-Metallurgy Laboratory
Metallurgical Research
Electro-Chemistry
Water Analysis
Physical Chemistry
Theoretical Chemistry
Advanced Physico-Chemical Laboratory
Internal Combustion Engines

Graduates from the four-year curriculum in Mining Engineering may pursue graduate work leading to the degree of Engineer of Mines. This fifth year is outlined on page 45. Electives may be chosen along any line approved by the Faculty.

A similar graduate curriculum in Metallurgy is outlined on page 46. This leads to the degree of Metallurgical Engineer.

Graduates in Civil, Electrical and Mechanical Engineering, who desire to specialize in Mining, may secure the degree of Engineer of Mines by completing the curriculum outlined on page 47. Considerable latitude will be granted men who are qualified to undertake research work.

COAL-FIRED ASSAY FURNACES

SPECIAL COURSES.

In addition to the nine regular curricula leading to degrees, mentioned above, a number of shorter courses are also offered. They are: *Chemistry and Assaying, Mining, Surveying, and Electricity.* They have been planned for the benefit of those who for various legitimate reasons, are unable to take the regular four-year courses.

The course in *Assaying and Chemistry* requires two years' work, although mature students, who have already some knowledge of chemistry, may complete it in one year.

The purpose of the course in *Surveying* is to develop competent land and mining surveyors and fair draftsmen. The essentials of it are a thorough knowledge of algebra, trigonometry, surveying, field practice, and drawing. One school year and the first term of a second will be required for the completion of this course.

A short course in *Mining* is offered to students, especially such as have had some practical experience, who may wish to fit themselves for holding important positions about mines or in ore-dressing plants, but who are unable, on account of the lack of preparation or of time, to take the full course in Mining Engineering. Besides mathematics this course includes general chemistry, assaying, mineralogy, geology, mining, surveying, and English.

A course in *Electricity* is offered to furnish the student with the theory of electricity, and acquaint him with its application in the arts. This subject is of great importance to every engineer, especially to the mining engineer, since electricity has become such an important factor in mining operations.

DEGREES.

1. The degree of Bachelor of Science in Mining Engineering, Bachelor of Science in Metallurgy, or Bachelor of Science in Civil Engineering, will be conferred on students who have attained the required standard in all the subjects of instruction in Curriculum I., II., III., IV., or V., and who submit a satisfactory thesis.

2. The degree of Bachelor of Science will be conferred on students who have satisfactorily completed Curriculum VI., and who submit a satisfactory thesis.

3. The degree of Master of Science will be given to students who, having graduated in Curriculum VI., complete satisfactorily a year's post-graduate work in residence at the school, and demonstrate their ability by research work and a thesis.

4. The degree of Engineer of Mines, Civil Engineer, or Metallurgical Engineer, will be conferred on one who, having previously been graduated in Curriculum I., II., III., IV., or V., has completed satisfactorily a year's post-graduate work in residence, or who has had professional experience in a responsible position for not less than three years. A satisfactory thesis recording the result of some original investigation or independent research in a subject connected with his course, accompanied by such drawings as may be necessary to illustrate it, is required of all candidates for advanced degrees.

THESES

All Seniors are required to carry on special investigations during the second semester and the results of this work are embodied in a thesis. The subject of the thesis must be reported to the Thesis Committee of the Faculty and approved not later than January fifteenth. The completed thesis must be filed with the Director not later than May twentieth.

The finished thesis should be typewritten (or printed) on eight and one-half by eleven-inch paper, written on one side only. The paper should be strong linen, unruled and without marginal lines. The thesis should be typewritten so as to have a margin all around of not less than one and one-half inches.

The thesis should have:

(1) A title page containing the subject of the thesis, the writer's name, and the date. It should show the approval of the professor under whose direction the work has been done and should also state the degree for which the candidate is an applicant.
(2) A table of contents.
(3) A list of illustrations.
(4) The body of the thesis including illustrations.
(5) A bibliography.
(6) An index.
(7) Original drawings or tracings.

All theses submitted by candidates for degrees become the property of the School of Mines and Metallurgy and may not be published without the approval of the head of the department under whose direction the investigation was made.

I. MINE ENGINEERING CURRICULUM.

Department.	No.	Course.	Hours Per Week		Hours Credit
			Lect.	Lab.	
FRESHMAN YEAR.					
First Semester.					
Chemistry	1a	General Chemistry	5	—	5
Chemistry	2a	Chemistry Laboratory	—	6	2
English	1a	Expository Literature	5	—	5
Mathematics	1a	College Algebra	5	—	5
Mathematics	3a	Plane Trigonometry			
Shop Practice and Drawing	1a	Descriptive Geometry	3	—	3
Shop Practice and Drawing	2a	Mechanical Drawing	—	6	2
Shop Practice and Drawing	12a	Wood Work	—	6	2
Second Semester.					
Chemistry	1b	General Chemistry	5	—	5
Chemistry	3b	Qualitative Lectures	2	—	2
Chemistry	4b	Qualitative Laboratory	—	6	2
English	1b	Descriptive Literature	5	—	5
Mathematics	5b	Spherical Trigonometry	5	—	5
Mathematics	7b	Analytical Geometry			
Mining	1b	Mining	2	—	2
Shop Practice and Drawing	2b	Mechanical Drawing	—	6	2
Shop Practice and Drawing	14b	Forge Shop	—	6	2
SOPHOMORE YEAR.					
First Semester.					
Chemistry	5a	Quantitative Analysis	2	—	2
Chemistry	6a	Quantitative Laboratory	—	6	2
Civil Engineering	1a	Surveying	2	—	2
Civil Engineering	2a	Field Practice	—	6	2
English	3a	Scientific Literature	1	—	1
Geology and Mineralogy	1a	Mineralogy	2	6	4
Mathematics	9a	Differential Calculus	5	—	5
Mathematics	11a	Integral Calculus			
Mining	3a	Mining	3	—	3
Modern Languages	3a	German	5	—	5
Modern Languages	5a	French, or			
Modern Languages	7a	Spanish			
Second Semester.					
Chemistry	6b	Quantitative Laboratory	—	9	3
English	3b	Argumentative Literature	1	—	1
Geology and Mineralogy	1b	Mineralogy	2	6	4
Mathematics	11b	Integral Calculus	5	—	5
Mathematics	13b	Differential Equations			
Mining	5b	Mine Surveying	2	—	2
Modern Languages	3b	German	5	—	5
Modern Languages	5b	French, or			
Modern Languages	7b	Spanish			
Physics	1b	General Physics	4	—	4
Physics	2b	Physics Laboratory	—	3	1
Civil Engineering	4	Topography	—	—	1

I. MINE ENGINEERING CURRICULUM.

Department.	No.	Course.	Hours Per Week		Hours Credit
			Lect.	Lab.	
JUNIOR YEAR.					
First Semester.					
Civil Engineering	7a	Lines of Communication	2	—	2
Civil Engineering	8a	Field Practice	—	3	1
Geology and Mineralogy	3a	General Geology	4	—	4
Mathematics	15a	General Mechanics	4	—	4
Metallurgy and Ore Dress'g	1a	Fire Assaying	2	—	2
Physics	3a	Physics	4	—	4
Physics	4a	Physics Laboratory	—	6	2
Physics	5a	Thermodynamics	3	—	3
Physics	6a	Steam Laboratory	—	3	1
Shop Practice and Draw'g	16a	Forge and Machine Shop			
Shop Practice and Draw'g	18a	or	—	6	2
Shop Practice and Draw'g	4a	Machine Drawing			
Second Semester.					
Civil Engineering	9b	Hydraulics	3	—	3
Civil Engineering	10b	Hydraulic Problems	—	3	1
Civil Engineering	11b	Masonry	3	—	3
Geology and Mineralogy	3b	General Geology	4	—	4
Geology and Mineralogy	4b	Geology Laboratory	—	6	2
Geology and Mineralogy	5b	Lithology	1	3	2
Mathematics	17b	Mechanics of Materials	3	—	3
Metallurgy and Ore Dress'g	2b	Assaying Laboratory	—	9	3
Metallurgy and Ore Dress'g	3b	General Metallurgy	3	—	3
Metallurgy and Ore Dress'g	31b	Elements of Ore Dressing	2	—	2
Mining	6	Junior Trip	—	—	3
SENIOR YEAR.					
First Semester.					
Civil Engineering	17a	Contracts	1	—	1
Civil Engineering	15a	Frame Structures	2	—	2
Civil Engineering	16a	Graphics	—	6	2
Geology and Mineralogy	9a	Economic Geology	4	—	4
Metallurgy and Ore Dress'g	5a	Metallurgy	4	—	4
Metallurgy and Ore Dress'g	6a	Metallurgy Laboratory	—	4	1
Metallurgy and Ore Dress'g	17a	Metallurgy Conference	1	—	1
Metallurgy and Ore Dress'g	33a	Ore Dressing	4	—	4
Metallurgy and Ore Dress'g	34a	Ore Dressing Problems	—	3	1
Mining	7a	Mining Law	1	—	1
Physics	7a	Electrical Machinery	3	—	3
Physics	8a	Dynamo Laboratory	—	6	2
		Senior Trips	—	—	—
Second Semester.					
Civil Engineering	27b	Compressed Air	2	—	2
Civil Engineering	28b	Compressed Air Laboratory	—	3	1
Geology and Mineralogy	9b	Economic Geology	4	—	4
Metallurgy and Ore Dress'g	5b	Metallurgy	4	—	4
Metallurgy and Ore Dress'g	33b	Ore Dressing	4	—	4
Metallurgy and Ore Dress'g	36b	Ore Dressing Laboratory	—	6	2
Mining	9b	Mine Management	2	—	2
Physics	7b	Electrical Machinery	3	—	3
Physics	8b	Dynamo Laboratory	—	3	1
		Thesis	—	6	2

II. MINE ENGINEERING CURRICULUM.

Coal Mining Option.

The first three years in II. are the same as I. See page 36.

Department.	No.	Course.	Hours Per Week		Hours Credit
			Lect.	Lab.	
SENIOR YEAR.					
First Semester.					
Civil Engineering	17a	Contracts	1	—	1
Civil Engineering	15a	Frame Structures	2	—	2
Civil Engineering	16a	Graphics	—	6	2
Geology and Mineralogy	9a	Economic Geology	4	—	4
Metallurgy and Ore Dressing	33a	Ore Dressing	4	—	4
Mining	7a	Mining Law	1	—	1
Mining	11a	Coal Mining Machinery	2	—	2
Mining	13a	Coal Mine Ventilation	2	—	2
Mining	14a	Coal Mine Surveying	—	6	2
Physics	7a	Electrical Machinery	3	—	3
Physics	8a	Dynamo Laboratory	—	6	2
		Senior Trips	—	—	—
Second Semester.					
Civil Engineering	27b	Compressed Air	2	—	2
Civil Engineering	28b	Compressed Air Laboratory	—	3	1
Geology and Mineralogy	9b	Economic Geology	4	—	4
Metallurgy and Ore Dressing	33b	Ore Dressing	4	—	4
Mining	9b	Mine Management	2	—	2
Mining	15b	Coal Mining Methods	4	—	4
Mining	16b	Fuel Testing	—	6	2
Physics	7b	Electrical Machinery	3	—	3
Physics	8b	Dynamo Laboratory	—	3	1
		Thesis	—	6	2

III. MINE ENGINEERING CURRICULUM.

Mining Geology Option.

The first three years in III. are the same as I. See page 36.

Department.	No.	Course.	Hours Per Week		Hours Credit
			Lect.	Lab.	
SENIOR YEAR.					
First Semester.					
Civil Engineering	17a	Contracts	1	—	1
Geology and Mineralogy	9a	Economic Geology	4	—	4
Geology and Mineralogy	7a	Geology of the U. S.	3	—	3
Geology and Mineralogy	11a	Petrography	3	9	6
Geology and Mineralogy	14a	Field Geology	—	6	2
Metallurgy and Ore Dressing	5a	Metallurgy	4	—	4
Metallurgy and Ore Dressing	6a	Metallurgy Laboratory	—	4	1
Metallurgy and Ore Dressing	33a	Ore Dressing	4	—	4
Mining	7a	Mining Law	1	—	1
		Senior Trips	—	—	—
Second Semester.					
Geology and Mineralogy	9b	Economic Geology	4	—	4
Geology and Mineralogy	11b	Petrography	3	6	5
Geology and Mineralogy	13b	Structural Geology	3	—	3
Geology and Mineralogy	15b	Geology Conference	1	—	1
Metallurgy and Ore Dressing	33b	Ore Dressing	4	—	4
Metallurgy and Ore Dressing	36b	Ore Dressing Laboratory	—	6	2
Mining	9b	Mine Management	2	—	2
Mining	17b	Methods of Prospecting	1	—	1
		Thesis	—	6	2
		Senior Trips	—	—	—

IV. METALLURGY CURRICULUM.

The Freshman Year in IV. is the same as in I. See page 36.

Department.	No.	Course.	Hours Per Week		Hours Credit
			Lect.	Lab.	
SOPHOMORE YEAR.					
First Semester.					
Chemistry	5a	Quantitative Analysis	2	—	2
Chemistry	6a	Quantitative Laboratory	—	6	2
Chemistry	7a	Physical Chemistry	2	—	2
Civil Engineering	1a	Surveying	2	—	2
Civil Engineering	2a	Field Practice	—	6	2
English	3a	Scientific Literature	1	—	1
Geology and Mineralogy	1a	Mineralogy	2	6	4
Modern Languages	3a	German	5	—	5
Modern Languages	5a	French, or			
Modern Languages	7a	Spanish			
Mathematics	9a	Differential Calculus	5	—	5
Mathematics	11a	Integral Calculus			
Second Semester.					
Chemistry	6b	Quantitative Laboratory	—	9	3
Chemistry	7b	Analytical Chemistry	2	—	2
English	3b	Argumentative Literature	1	—	1
Geology and Mineralogy	1b	Mineralogy	2	6	4
Modern Languages	3b	German	5	—	5
Modern Languages	5b	French, or			
Modern Languages	7b	Spanish			
Mathematics	11b	Integral Calculus	5	—	5
Mathematics	13b	Differential Equations			
Physics	2b	Physics Laboratory	—	3	1
Physics	1b	General Physics	4	—	4

IV. METALLURGY CURRICULUM.

Department.	No.	Course.	Hours Per Week		Hours Credit
			Lect.	Lab.	
JUNIOR YEAR.					
First Semester.					
Chemistry	9a	Electrochemistry	2	—	2
Chemistry	10a	Electrochemistry Laboratory	—	3	1
Chemistry	8a	Quantitative Analysis	—	6	2
Geology and Mineralogy	3a	General Geology	4	—	4
Mathematics	15a	General Mechanics	4	—	4
Metallurgy and Ore Dress'g	1a	Fire Assaying	2	—	2
Physics	3a	Physics	4	—	4
Physics	4a	Physics Laboratory	—	6	2
Physics	5a	Thermodynamics	3	—	3
Physics	6a	Steam Laboratory	—	3	1
Second Semester.					
Chemistry	11b	Chemical Memoirs	2	—	2
Civil Engineering	9b	Hydraulics	3	—	3
Civil Engineering	10b	Hydraulic Problems	—	3	1
Geology and Mineralogy	3b	General Geology	4	—	4
Geology and Mineralogy	4b	Geology Laboratory	—	6	2
Geology and Mineralogy	5b	Lithology	1	3	2
Mathematics	17b	Mechanics of Materials	3	—	3
Metallurgy and Ore Dress'g	2b	Assaying Laboratory	—	9	3
Metallurgy and Ore Dress'g	3b	General Metallurgy	3	—	3
Metallurgy and Ore Dress'g	31b	Elements of Ore Dressing	2	—	2
Mining	6	Junior Trip	—	—	3
SENIOR YEAR.					
First Semester.					
Civil Engineering	17a	Contracts	1	—	1
Metallurgy and Ore Dress'g	5a	Metallurgy	4	—	4
Metallurgy and Ore Dress'g	6a	Metallurgy Laboratory	—	7	2
Metallurgy and Ore Dress'g	7a	Alloys and Metallography	2	—	2
Metallurgy and Ore Dress'g	11a	Metallurgy Organization	2	—	2
Metallurgy and Ore Dress'g	13a	Metallurgical Problems	1	—	1
Metallurgy and Ore Dress'g	17a	Metallurgical Conference	1	—	1
Metallurgy and Ore Dress'g	8a	Alloys and Metallography	—	3	1
Metallurgy and Ore Dress'g	33a	Ore Dressing	4	—	4
Metallurgy and Ore Dress'g	34a	Ore Dressing Problems	—	3	1
Mining	7a	Mining Law	1	—	1
Physics	7a	Electrical Machinery	3	—	3
Physics	8a	Dynamo Laboratory	—	6	2
		Senior Trips	—	—	—
Second Semester.					
Civil Engineering	27b	Compressed Air	2	—	2
Civil Engineering	28b	Compressed Air Laboratory	—	3	1
Metallurgy and Ore Dress'g	5b	Metallurgy	4	—	4
Metallurgy and Ore Dress'g	9b	Electro-Metallurgy	5	—	5
Metallurgy and Ore Dress'g	15b	Metallurgical Memoirs	1	—	1
Metallurgy and Ore Dress'g	33b	Ore Dressing	4	—	4
Metallurgy and Ore Dress'g	36b	Ore Dressing Laboratory	—	6	2
Physics	7b	Electrical Machinery	3	—	3
Physics	8b	Dynamo Laboratory	—	3	1
		Thesis	—	6	2

V. CIVIL ENGINEERING CURRICULUM.

The Freshman Year in V. is the same as in I. See page 36.

Department.	No.	Course.	Hours Per Week		Hours Credit
			Lect.	Lab.	
SOPHOMORE YEAR.					
First Semester.					
Civil Engineering	1a	Surveying	4	—	4
Civil Engineering	2a	Field Practice	—	9	3
English	3a	Scientific Literature	1	—	1
Modern Languages	3a	German	5	—	5
Modern Languages	5a	French, or			
Modern Languages	7a	Spanish			
Mathematics	9a	Differential Calculus	5	—	5
Mathematics	11a	Integral Calculus			
Mining	3a	Mining	3	—	3
Shop Practice and Drawing	4a	Machine Drawing	—	6	2
Second Semester.					
Civil Engineering	3b	Astronomy	2	—	2
Civil Engineering	6b	Field Practice and Graphics	—	12	4
English	3b	Argumentative Literature	1	—	1
Modern Languages	3b	German	5	—	5
Modern Languages	5b	French, or			
Modern Languages	7b	Spanish			
Mathematics	11b	Integral Calculus	5	—	5
Mathematics	13b	Differential Equations			
Mining	5b	Mine Surveying	2	—	2
Physics	1b	General Physics	4	—	4
Physics	2b	Physics Laboratory	—	3	1
Civil Engineering	4	Topography	—	—	1

V. CIVIL ENGINEERING CURRICULUM.

Department.	No.	Course.	Hours Per Week		Hours Credit
			Lect.	Lab.	
JUNIOR YEAR.					
First Semester.					
Civil Engineering	7a	Lines of Communication	2	—	2
Civil Engineering	8a	Field Practice	—	6	2
Civil Engineering	12a	Graphics	—	3	1
Geology and Mineralogy	3a	General Geology	4	—	4
Mathematics	15a	General Mechanics	4	—	4
Physics	3a	Physics	4	—	4
Physics	4a	Physics Laboratory	—	6	2
Physics	5a	Thermodynamics	3	—	3
Physics	6a	Steam Laboratory	—	3	1
Second Semester.					
Civil Engineering	9b	Hydraulics	3	—	3
Civil Engineering	10b	Hydraulic Problems	—	3	1
Civil Engineering	11b	Masonry	3	—	3
Civil Engineering	13b	Roads and Pavements	3	—	3
Civil Engineering	14b	Engineering Laboratory	—	6	2
Geology and Mineralogy	3b	General Geology	4	—	4
Geology and Mineralogy	4b	Geology Laboratory	—	6	2
Mathematics	17b	Mechanics of Materials	3	—	3
Metallurgy and Ore Dressing	3b	General Metallurgy	3	—	3
SENIOR YEAR.					
First Semester.					
Civil Engineering	17a	Contracts	1	—	1
Civil Engineering	15a	Frame Structures	2	—	2
Civil Engineering	16a	Engineering Design	—	9	3
Civil Engineering	19a	Water Supply	5	—	5
Civil Engineering	21a	Irrigation	3	—	3
Civil Engineering	23a	Railroad Economics	3	—	3
Physics	7a	Electrical Machinery	3	—	3
Physics	8a	Dynamo Laboratory	—	6	2
Second Semester.					
Civil Engineering	25b	Bridges	5	—	5
Civil Engineering	27b	Compressed Air	2	—	2
Civil Engineering	28b	Compressed Air Laboratory	—	3	1
Civil Engineering	29b	Sanitary Engineering	5	—	5
Civil Engineering	31b	Masonry Design	3	—	3
Civil Engineering	32b	Masonry Design Practice	—	3	1
Physics	7b	Electrical Machinery	3	—	3
Physics	8b	Dynamo Laboratory	—	3	1
		Thesis	—	6	2

VI. GENERAL SCIENCE CURRICULUM.

The Freshman Year in VI. is the same as in I. See page 36.

Department.	No.	Course.	Hours Per Week		Hours Credit
			Lect.	Lab.	
SOPHOMORE YEAR.					
First Semester.					
English	5a	Exposition	5	—	5
Geology and Mineralogy	1a	Mineralogy	2	6	4
Modern Languages	3a	Scientific German	5	—	5
		Electives	7	12	11
Second Semester.					
English	5b	Argumentation	5	—	5
Geology and Mineralogy	1b	Mineralogy	2	6	4
Modern Languages	3b	Scientific German	5	—	5
Physics	2b	Physics Laboratory	—	3	1
		Electives	7	9	10
JUNIOR YEAR.					
First Semester.					
Geology and Mineralogy	3a	General Geology	4	—	4
Modern Languages	5a	French or Spanish	5	—	5
Modern Languages	7a				
Physics	3a	General Physics	4	—	4
Physics	4a	General Physics Laboratory	—	6	2
		Electives	6	12	10
Second Semester.					
Geology and Mineralogy	3b	General Geology	4	—	4
Geology and Mineralogy	4b	General Geology Laboratory	—	6	2
Modern Languages	5b	French or Spanish	5	—	5
Modern Languages	7b				
		Electives	10	12	14

SENIOR YEAR.

Subjects All Elective.—Nineteen hours of recitation and eighteen hours of laboratory work must be elected. In the second semester six hours a week thesis work is to be included in the laboratory time.

All electives throughout the course must be chosen, with the approval of the faculty, from one of the following groups:

Physics-Mathematics, Chemistry-Mathematics, Physics-Chemistry-Mathematics, Chemistry-Metallurgy, Chemistry-Geology, Geology-Mining, Mining-Metallurgy.

VII. GRADUATE CURRICULUM IN MINE ENGINEERING.*

Department.	No.	Course.	Hours Per Week		Hours Credit
			Lect.	Lab.	
First Semester.					
Geology and Mineralogy...	7a	Geology of the U. S.....	3	—	3
Geology and Mineralogy...	11a	Petrography	3	9	6
Metallurgy and Ore Dressing	13a	Metallurgy Problems.....	1	—	1
Mining	11a	Mining Machinery.....	2	—	2
Mining	13a	Mine Ventilation.....	2	—	2
Mining	18a	Mine Plant Design	—	3	1
Mining	19a	Mining Economics	1	—	1
		Thesis	—	6	2
		Electives	6	—	6
Second Semester.					
Civil Engineering.....	31b	Masonry Design.....	3	—	3
Geology and Mineralogy...	11b	Petrography	3	6	5
Geology and Mineralogy...	13b	Structural Geology.....	3	—	3
Mining	15b	Coal Mining Methods.....	4	—	4
Mining	18b	Mine Plant Design.....	—	3	1
Physics	15b	Internal Combustion Engines	3	—	3
		Thesis	—	6	2
		Electives	3	3	4

*These courses are open to students holding the degree of Bachelor of Science in Mine Engineering. The degree of Engineer of Mines will be conferred upon those who complete the course outlined.

VIII. GRADUATE CURRICULUM IN METALLURGY.*

Department.	No.	Course.	Hours Per Week		Hours Credit
			Lect.	Lab.	
First Semester.					
Chemistry	13a	Theoretical Chemistry	2	—	2
Geology and Mineralogy	7a	Geology of the U. S.	3	—	3
Metallurgy and Ore Dressing	19a	Metallurgy Plant	2	—	2
Metallurgy and Ore Dressing	20a	Metallurgy Plant Design	—	6	2
Metallurgy and Ore Dressing	21a	Cyaniding	4	—	4
Metallurgy and Ore Dressing	22a	Cyanide Laboratory	—	6	2
Metallurgy and Ore Dressing	25a	Metallurgical Research	5	—	5
Mining	19a	Mining Economics	1	—	1
		Thesis	—	6	2
		Electives	2	—	2
Second Semester.					
Chemistry	13b	Theoretical Chemistry	2	—	2
Chemistry	14b	Advanced Chemistry Laboratory	—	6	2
Civil Engineering	31b	Masonry Design	3	—	3
Metallurgy and Ore Dress'g	27b	Advanced Metallurgy Problems	2	—	2
Metallurgy and Ore Dressing	25b	Metallurgical Research	5	—	5
Metallurgy and Ore Dressing	23b	Ore Supply	2	—	2
Metallurgy and Ore Dressing	22b	Cyanide Laboratory	—	6	2
Physics	15b	Internal Combustion Engines	3	—	3
		Thesis	—	6	2
		Electives	2	—	2

*These courses are open to students holding the degree of Bachelor of Science in Metallurgy. The degree of Metallurgical Engineer will be conferred upon those who complete the course outlined.

IX. GRADUATE CURRICULUM FOR ENGINEERS.*

Department.	No.	Course.	Hours Per Week		Hours Credit
			Lect.	Lab.	
FIRST YEAR.					
First Semester.					
Chemistry	5a	Quantitative Analysis	2	—	2
Chemistry	6a	Quantitative Laboratory	—	6	2
Geology and Mineralogy	1a	Mineralogy	2	6	4
Geology and Mineralogy	3a	General Geology	4	—	4
Metallurgy and Ore Dress'g	1a	Fire Assaying	2	—	2
Metallurgy and Ore Dress'g	2a	Assay Laboratory	—	9	3
Mining	3a	Mining	3	—	3
		Electives	6	—	6
Second Semester.					
Chemistry	6b	Quantitative Laboratory	—	9	3
Geology and Mineralogy	1b	Mineralogy	2	6	4
Geology and Mineralogy	3b	General Geology	4	—	4
Geology and Mineralogy	4b	Geology Laboratory	—	6	2
Metallurgy and Ore Dress'g	3b	General Metallurgy	3	—	3
Metallurgy and Ore Dress'g	31b	Elements of Ore Dressing	2	—	2
Mining	5b	Mine Surveying	2	—	2
		Electives	6	—	6
Mining	6	Junior Trip	—	—	3
SECOND YEAR.					
First Semester.					
Chemistry	6a	Quantitative Laboratory	—	6	2
Civil Engineering	17a	Contracts	1	—	1
Geology and Mineralogy	9a	Economic Geology	4	—	4
Metallurgy and Ore Dress'g	5a	Metallurgy	4	—	4
Metallurgy and Ore Dress'g	17a	Metallurgy Conference	1	—	1
Metallurgy and Ore Dress'g	6a	Metallurgy Laboratory	—	4	1
Metallurgy and Ore Dress'g	33a	Ore Dressing	4	—	4
Metallurgy and Ore Dress'g	34a	Ore Dressing Problems	—	3	1
Mining	7a	Mining Law	1	—	1
		Thesis	—	6	2
		Electives	4	—	4
		Senior Trips	—	—	—
Second Semester.					
Civil Engineering	27b	Compressed Air	2	—	2
Civil Engineering	28b	Compressed Air Laboratory	—	3	1
Geology and Mineralogy	5b	Lithology	1	3	2
Geology and Mineralogy	9b	Economic Geology	4	—	4
Metallurgy and Ore Dress'g	5b	Metallurgy	4	—	4
Metallurgy and Ore Dress'g	33b	Ore Dressing	4	—	4
Metallurgy and Ore Dress'g	36b	Ore Dressing Laboratory	—	6	2
Mining	9b	Mine Management	2	—	2
		Thesis	—	6	2
		Electives	2	—	2

*This two-year course is planned for graduates in Civil, Electrical, or Mechanical Engineering, who desire to work along mining lines. The degree, Mining Engineer, will be conferred on students who have received the Bachelor of Science Degree in Engineering, and who complete the two-year course as outlined.

CHEMISTRY

PROFESSOR GOTTSCHALK, ASSISTANT PROFESSOR TEST, MR. WALKER, MR. RANDOLPH, MR. MCGOUGHRAN, MR. LANE.

Equipment.

One entire building is given to chemistry. The main chemical lecture room occupies the entire south wing of the building. The laboratories for general chemistry and for qualitative analysis, on the first floor of the main building, accommodate together about one hundred forty students. The quantitative laboratories on the second floor have desk room for seventy-five students working at one time. In the north wing is a smaller lecture room, as well as a capacious laboratory for advanced students.

Excellent ventilation is provided by a thirteen-horse-power motor and suction fan connected with individual hoods over each laboratory desk and with the long lines of fume chambers distributed throughout the building. Gas, water, and air blast are supplied conveniently, while a steam-heated still of five gallons an hour capacity furnishes ample distilled water.

The equipment includes twenty-four first-class analytical balances, sixty sets of good analytical weights, sixty sets of volumetric instruments with Bureau of Standards stamps, a liberal supply of platinum ware, and a good selection of precision instruments for physico-chemical and electro-chemical measurements.

Courses.

1a. GENERAL CHEMISTRY. *Lectures.* (Test)

This course is a comprehensive study of the general principles of chemistry and of the more important non-metals. The ionic theory, phase rule, and mass-law are introduced, and applied at advantageous points in the lectures. Special stress is laid on experimental demonstrations. The class is divided into several smaller sections for recitations and discussion of problems.

Prerequisites: Entrance requirements.

Required in I., II., III., IV., V., and VI.

Freshman year, first semester, five hours per week. Credit five hours.

Text: Kahlenberg, *Outlines of Chemistry.*
Hale, *Calculations of General Chemistry.*

1b. GENERAL CHEMISTRY. *Lectures.* (Test)

Continuation of course 1a; devoted to the chemistry of the metals, with special consideration of the reactions employed in analytical chemistry, in metallurgy, and in geology. The Periodic Law is followed throughout.

Prerequisites: Chemistry 1a and 2a.

Required in I., II., III., IV., V., and VI.

Freshman year, second semester, five hours per week. Credit five hours.

Text: Kahlenberg, *Outlines of Chemistry.*

2a. GENERAL CHEMISTRY. *Laboratory.* (Test, Randolph)

The laboratory work accompanying general chemistry consists of experiments which are largely quantitative, and which are intended to teach stoichiometrical relations from the first.

Prerequisite: Must be accompanied by Chemistry 1a.

Required in I., II., III., IV., V., and VI.

Freshman year, first semester, two afternoons per week. Credit two hours.

Text: Ransom, *Experimental General Chemistry* and *Manuscript Notes.*

3b. QUALITATIVE ANALYSIS. *Lectures.* (Test)

This course is an exposition of the principles underlying the qualitative separation and identification of the commoner elements found in minerals, rocks, and metallurgical products.

Prerequisites: Chemistry 1a and 2a and accompanied by 1b.

Required in I., II., III., IV., V., and VI.

Freshman year, second semester, two hours per week. Credit two hours.

Text: Bailey and Cady, *Qualitative Analysis.*

4b. QUALITATIVE ANALYSIS. *Laboratory.*
(Test, Walker, McGoughran)

The student is drilled in the practical separation and identification of ordinary mineral constituents, the examples for practice being limited to solutions or mixtures soluble in acids. While the wet methods are preferred, the ordinary blowpipe tests and spec-

troscopic methods are also taught; very little attention is paid to tests for acids.

Prerequisite: Chemistry 2a, and must be accompanied by 3b.

Required in I., II., III., IV., V., and VI.

Freshman year, second semester, two afternoons a week. Credit two hours.

Text: Bailey and Cady, *Qualitative Analysis.*

5a. QUANTITATIVE ANALYSIS. *Lectures.* (Gottschalk)

The subjects discussed in this course are as follows: The preparation for analysis of minerals, rocks, and metallurgical products; qualitative detection of the impurities present in such substances; the balance, weights, and the process of weighing; simple gravimetric analysis; analysis of silicate rocks, and application to clay, shale, and slag analysis; volumetric instruments, their calibration and use; volumetric analyses, standard solutions, indicators; technical volumetric methods in general; wet assaying of copper, zinc, and lead ores and concentrates. Problems in the calculations of analytical chemistry are also discussed.

Prerequisites: Chemistry 3b, 4b.

Required in I., II., III., IV., and IX.

Sophomore year, first semester, two hours per week. Credit two hours.

Text: *Manuscript Notes.*
Miller, *Calculations of Analytical Chemistry.*

6a. QUANTITATIVE ANALYSIS. *Laboratory.*
(Gottschalk, Walker)

Practice in the preparation for analysis of minerals, ores, and metallurgical products, and their qualitative analysis with especial reference to elements present in smaller quantities; given as a continuation of the course in qualitative analysis and as an introduction to the following technical analysis. Before beginning actual quantitative analysis, the student is required to make a careful study of the balance and of the method of weighing. The rest of the time is given to exercises in simple gravimetric analysis, with some volumetric analysis, chiefly on analyzed mixtures, closing with a (technical) clay analysis.

Prerequisites: Chemistry 3b, 4b, and must be accompanied by 5a.

Required in I., II., III., IV., and IX.

Sophomore year, first semester, two afternoons per week. Credit two hours.

Text: Miller, *Quantitative Analysis for Mining Engineers.*
Miller, *Calculations of Analytical Chemistry.*

6b. QUANTITATIVE ANALYSIS. *Laboratory.* (Gottschalk)

Technical methods for the determination of copper, lead, zinc, arsenic, antimony, sulphur, and coal analysis. Essential parts of the course are the speed tests, in which students are required to report correct results on a number of copper, zinc, and lead ores within a stated time.

Actual ores, analyzed by the instructing staff, are on hand in large quantity, and the students are trained to attain the same degree of accuracy which obtains in smelter laboratories.

Prerequisite: Chemistry 6a.

Required in I., II., III., IV., and IX.

Sophomore year, second semester, three afternoons per week. Credit three hours.

Text: Seamon, *Manual for Assayers and Chemists.*

7a. PHYSICAL CHEMISTRY. *Lectures.* (Gottschalk)

This course is intended as an introduction to physical chemistry. The qualitative and quantitative theories of chemical equilibria as given by the phase rule and by the mass law are studied first. Towards the end of the term the basis of the ionic theory is discussed.

Prerequisite: Chemistry 4b.

Required in IV.

Sophomore year, first semester, two hours per week. Credit two hours.

Text: *Manuscript Notes.*

7b. ANALYTICAL CHEMISTRY. *Lectures.* (Gottschalk)

The application of the ionic theory to analytical chemistry is taken up in detail; a select number of lecture experiments illustrate the main propositions advanced.

Prerequisite: Chemistry 7a.

Required in IV.

Sophomore year, second semester, two hours per week. Credit two hours.

Text: Ostwald, *Foundations of Analytical Chemistry.*

8a. QUANTITATIVE ANALYSIS. *Laboratory.* (Gottschalk)

This course is offered primarily for students of metallurgy who desire to become acquainted with the methods of analysis of mattes, speisses, crude and refined lead and copper bullion, spelter, alloys, and similar material. No required schedule is laid out; students are strongly recommended to employ some of this time in elemen-

tary physico-chemical measurements, as this subject has become nearly indispensable in their branch.

Prerequisite: Chemistry 6b.

Required in IV.

Junior year, first semester, two afternoons per week. Credit two hours.

9a. ELECTRO-CHEMISTRY. *Lectures.* (Gottschalk)

The course opens with a brief theoretical introduction to the Nernst theory. The main object of the lectures is the application to the theory of the deposition of metals out of aqueous solutions as practiced in electro-metallurgy.

Prerequisite: Chemistry 7b.

Required in IV.

Junior year, first semester, two lectures per week. Credit two hours.

Text: *Manuscript Notes.*

10a. ELECTRO-CHEMISTRY. *Laboratory.* (Gottschalk)

The practical work consists of the measurement of electrolytic conductances and of single differences of potential, followed by experiments on the relation between the electrode potential and current density, and on the electrolytic refining of metals.

Prerequisite: Must be accompanied by Chemistry 9a.

Required in IV.

Junior year, first semester, one afternoon per week. Credit one hour.

Text: *Manuscript Notes.*

11b. CHEMICAL MEMOIRS. *Class-Room Work.* (Gottschalk)

Carefully prepared abstracts of current articles or of special subjects are prepared by the student for this course.

Prerequisite: Chemistry 9a.

Required in IV.

Junior year, second semester, two hours per week. Credit two hours.

Elective and Graduate Courses.

12b. WATER ANALYSIS. *Laboratory.* (Test)

This course is designed to meet the wants of engineering students. Sanitary water analysis and boiler water analysis are offered, although students interested in geology may substitute mineral water analysis for some of the work.

Prerequisite: Chemistry 6a.

Elective, second semester, two afternoons per week. Credit two hours.

13a. THEORETICAL CHEMISTRY. *Lectures.* (Gottschalk)

The applications of theoretical chemistry to fundamental metallurgical principles are assuming such prominence and leading to such important results that a knowledge of this subject is indispensable to the metallurgical engineer who desires to keep pace with the developments in this field. To meet this demand a course for graduate students is offered, presenting the subject of chemical equilibria from the thermodynamic point of view, including a consideration of the technical applications made by Nernst, Le Chatelier, Haber, von Jueptner and others. The student is expected to do considerable reading of original articles in English, German, and French scientific journals and books.

Prerequisites: Chemistry 9a, Mathematics 15a and 17a, and Physics 5a.

Required in VIII.

Graduate course, first semester, two lectures per week. Credit two hours.

13b. THEORETICAL CHEMISTRY. *Lectures.* (Gottschalk)

Continuation of Chemistry 13a.

Required in VIII.

Second semester, two lectures per week. Credit two hours.

Reference: Nernst, *Theoretical Chemistry.*

14b. ADVANCED CHEMISTRY. *Laboratory.* (Gottschalk)

This is an advanced course to accompany the lectures in Theoretical Chemistry, and includes the study and measurements of typical chemical equilibria, either as a repetition of classical researches in this field, or preferably on original problems. The equipment for this work includes measuring instruments of the most approved types for high temperature, electro-thermic and physico-chemical work, and special apparatus built in the school shops.

Prerequisite: Must be accompanied by Chemistry 13b.

Required in VIII.

Second semester, two afternoons per week. Credit two hours.

CIVIL ENGINEERING.

PROFESSOR HARRIS, MR. MCVEY, MR. NEEDLES.

Equipment.

On the third floor of Norwood Hall are located three large well lighted and well equipped drafting rooms, two lecture rooms, and a department library and study.

The equipment for field practice includes fourteen transits, one theodolite, two plane tables, one solar compass, one railroad compass, eleven levels, together with barometers, telemeters, chains, tapes, level rods, and other necessary equipment for field practice. A number of transits are equipped with solar attachments and others with attachments for underground work. The instrument room is equipped with separate lockers for the equipment of each surveying squad.

A well lighted basement room is equipped with the necessary apparatus for cement testing.

In the power plant are one duplex single-stage air compressor, one compound two-stage air compressor, and one centrifugal pump so arranged that it can be operated as a two-stage or as a single-stage pump. With these there are provided the necessary gages, orifices, indicators, etc., to make complete tests.

Courses.

1a. SURVEYING. *Lectures.* (McVey)

A general course in surveying, including the adjustments, uses, and limitations of transits, levels, and solar compasses, and the minor instruments. Students are drilled in traversing, computing areas, establishing meridians, city surveying, topographic methods, triangulating, and precise leveling.

Prerequisite: Mathematics 5b.

Required in I., II., III., IV., and V.

Sophomore year, first semester, four hours per week in V., credit four hours; two hours per week in I., II., III., and IV., credit two hours.

Text: Breed and Hosmer, *Surveying.*

2a. FIELD PRACTICE. *Laboratory.* (McVey, Needles)

Field work and problems to accompany the class-room work in surveying.

Prerequisite: To accompany Civil Engineering 1a.

Required in I., II., III., IV., and V.

Sophomore year, first semester, three afternoons per week in V. Credit three hours.

Sophomore year, first semester, two afternoons per week in I., II., III., and IV. Credit two hours.

4. TOPOGRAPHY. *Field Work.* (Harris, McVey, Needles)

Students taking this course are required to spend one week in topographic surveying. The class is divided into parties of about five and to each party is assigned a field outfit and an area to survey. Each party elects its captain and all proceed under the general supervision of the instructors. The students in Civil Engineering are required to convert their notes into a topographic map during the first semester Junior year.

Prerequisites: Civil Engineering 1a, 2a.

Required in I., II., III., and V.

Summer vacation, one week preceding first semester, Junior year. Credit one hour.

3b. ASTRONOMY. *Lectures.* (McVey)

A course in descriptive astronomy with special attention to matter affecting the establishing of meridians, finding longitude, and time.

Prerequisite: Civil Engineering 1a.

Required in V.

Sophomore year, second semester, two hours per week. Credit two hours.

6b. FIELD PRACTICE AND GRAPHICS. *Laboratory.* (McVey)

During inclement weather the student is instructed in the construction and use of slide rules and similar devices, in the construction of charts for reducing the labor of computations, and in the determination of empirical coefficients involved in various formulas used in engineering computations. In favorable weather, field practice is continued, extending the work commenced in the first term.

Prerequisites: Civil Engineering 1a and 2a.

Required in V.

Sophomore year, second semester, four afternoons per week. Credit four hours.

7a. LINES OF COMMUNICATION. *Lectures.* (McVey)

Covers the mathematical problems in the location of railways, highways, and canals, and in setting out and estimating earthwork, laying out track, and locating and constructing tunnels.

Prerequisites: Civil Engineering 1a and 2a.

Required in I., II., III., and V.

Junior year, first semester, two hours per week. Credit two hours.

Text: Nagle, *Field Manual for Railroad Engineers.*

8a. FIELD PRACTICE. (McVey, Needles)

Supplementary to the lectures in lines of communication. Typical problems and methods presented in the text are executed in the field in such a way as to give the student confidence in the methods and in his own ability.

Prerequisite: Civil Engineering 5a.

Required in I., II., III., and V.

Junior year, first semester, two afternoons per week in V. Credit two hours.

Junior year, first semester, one afternoon per week in I., II., and III. Credit one hour.

9b. HYDRAULICS. *Lectures.* (Harris)

The theory of hydrostatics and of hydraulics and application to the dependent problems in engineering practice, such as the determination of empirical coefficients and their application in determining the flow of water through orifices, weirs, pipes, canals, and rivers. Also the theory of hydraulic motors and dynamic pumps and the practice in such machines.

Prerequisite: Mathematics 15a.

Required in I., II., III., IV., and V.

Junior year, second semester, three hours per week. Credit three hours.

Text: Merriman, *Hydraulics.*

10b. HYDRAULIC PROBLEMS. *Laboratory.* (Harris)

One afternoon per week is assigned to the solution of problems in hydraulics and hydrostatics under the direction of the instructor. This includes the testing of the hydraulic equipment of the school, including the air-lift pump.

Prerequisite: To accompany Civil Engineering 9b.

Required in I., II., III., and V.

Junior year, second semester, one afternoon per week. Credit one hour.

11b. MASONRY. *Lectures.* (McVey)

Treats of the economic properties of building stone, brick, and cement; the proportioning, mixing, and placing of concrete; preparation of foundations; and strength and stability of masonry structures, including dams, piers, abutments, retaining walls and arches. Also the elements of concrete steel construction, both theory and practice.

Prerequisites: Mathematics 15a, and Civil Engineering 5a. To be accompanied by Mathematics 17b.

Required in I., II., III., and V.

Junior year, second semester, three hours per week. Credit three hours.

Text: Baker, *Masonry Construction.*

12a. GRAPHICS, STRESSES. *Laboratory.* (Harris, McVey)

A thorough drilling in the graph determination of stresses in the simple structures used in engineering, such as roofs, simple bridges, three-hinged arches, masonry arches, domes, towers, and derricks.

Prerequisites: Physics 2b and Shop Practice and Drawing 2b.

Required in V.

Junior year, first semester, one afternoon per week. Credit one hour.

13b. ROADS AND PAVEMENTS. *Lectures.* (McVey)

A discussion of the principles and practice as applied to the location, construction, and maintenance of highways and streets, including the study of various methods and materials applied in street paving.

Prerequisites: Civil Engineering 5a and Mathematics 15a. To be accompanied by Mathematics 17b and Civil Engineering 11b.

Required in V.

Junior year, second semester, three hours per week. Credit three hours.

14b. ENGINEERING LABORATORIES. *Laboratory.* (Harris, McVey)

It gives the student time and facilities for making such tests, and performing such experiments as the instructor may specify. With other subjects it will include the tests of cements and mortars.

Prerequisites: Supplementary to Civil Engineering 9b, 11b, and 13b.

Required in V.

Junior year, second semester, two afternoons per week. Credit two hours.

15a. FRAMED STRUCTURES. *Lectures.* (Harris)

Treats of general methods of determining stresses in such structures as single-span bridges, roofs, towers, three-hinged arches, etc., and of the design of individual members, such as beams, posts, and rods, to carry the determined stresses.

Prerequisites: Civil Engineering 12a and Mathematics 17b.

Required in I., II., and V.

Senior year, first semester, two hours per week. Credit two hours.

16a. ENGINEERING DESIGNING. *Laboratory.* (Harris)

The student working under the direction of the instructor works out the design of as many structures as time permits. The work includes making the necessary computations, finished drawings, and specifications.

Prerequisites: Supplementary to Civil Engineering 15a, 19a, and 21a.

Required in I., II., and V.

Senior year, first semester, two afternoons per week. Credit two hours.

17a. CONTRACTS. *Lectures.* (Harris)

A lecture course in the laws of contracts, and the preparation of specifications.

Required in I., II., III., IV., V., and IX.

Senior year, first semester, one hour per week. Credit one hour.

Text: Tucker, *Contracts in Engineering.*

19a. WATER SUPPLY. *Lectures.* (Harris)

Covers the selection, storing, transporting, purification, and delivering water to cities and towns.

Prerequisites: Civil Engineering 9b and 11b.

Required in V.

Senior year, first semester, five hours per week. Credit five hours.

Text: Turneaure and Russell, *Water Supply.*

21a. IRRIGATION ENGINEERING AND RIVER AND HARBOR IMPROVEMENTS. *Lectures.* (Harris)

The time here allotted is given to the study of special problems arising in the design of irrigation projects, such as location of the main canal and its head works, mapping the lands, locating the secondary canals, special methods of measuring and delivering the water, necessary water consumption, etc., and to the study of the

cause and control of floods, protection of river banks, improvement of navigation, and protection and improvement of harbors.

Prerequisites: Civil Engineering 9b and 11b.

Required in V.

Senior year, first semester, three hours per week. Credit three hours.

23a. RAILROAD ECONOMICS. *Lectures.* (McVey)

Treats of the economic principles involved in railway location and of improvement of old lines as affected by curvature, grades, first cost, cost of maintenance, and traffic.

Prerequisite: Civil Engineering 7a.

Required in V.

Senior year, first semester, three hours per week. Credit three hours.

Text: Beahan, *Field Practice of Railway Location.*

25b. BRIDGES (HIGHER STRUCTURES). *Lectures.* (Harris)

Covers the study of effects of concentrated wheel loads on simple bridges and the study of cantilever, wing and suspension bridges and elastic arches.

Prerequisite: Civil Engineering 15a.

Required in V.

Senior year, second semester, five hours per week. Credit five hours.

Text: Johnson, *Framed Structures.*

27b. COMPRESSED AIR. *Lectures.* (Harris)

Covers the theory of air compression, measurement and transmission, and the practical application in the industries.

Prerequisites: Civil Engineering 9b, Mathematics 17b, and Physics 5a.

Required in I., II., IV., V., and IX.

Senior year, second semester, two hours per week. Credit two hours.

Text: Harris, *Compressed Air.*

28b. COMPRESSED AIR LABORATORY. *Laboratory.* (Harris)

The students are required to examine, dissect, and adjust the air compressors in the school equipment, and to determine their volumetric and mechanical efficiency. Tests are made determining the frictional loss in air pipes, elbows, etc., and output and efficiency of centrifugal blowers and fans.

Prerequisite: Supplementary to Civil Engineering 27b.

Required in I., II., IV., V., and IX.

Senior year, second semester, three hours per week. Credit one hour.

29b. SANITARY ENGINEERING. *Lectures.* (Harris)

Treats of the precautions necessary to protect water supplies from polution and the methods available for purification of sewage. Also the construction of sewer systems for the collection and transportation of sewage and storm waters.

Prerequisite: Civil Engineering 19a.

Required in V.

Senior year, second semester, five hours per week. Credit five hours.

Text: Followell, *Sewage of Cities.*

31b. MASONRY DESIGNS AND CONCRETE STEEL. *Lectures.* (Harris)

Treats of the higher structures in masonry, such as high masonry dams, concrete steel dams, arches, and full theoretic and practical study of concrete steel construction.

Prerequisites: Civil Engineering 11b, 15a, and 25b.

Required in V., VII., and VIII.

Senior year, second semester, three hours per week. Credit three hours.

32b. MASONRY DESIGNS—PRACTICE. *Laboratory.* (Harris)

The theories developed in Civil Engineering 31b are here applied in the complete design of as many structures as the time will permit. Specifications for at least one structure is required.

Prerequisite: Supplementary to Civil Engineering 31b.

Required in V.

Senior year, second semester, three hours per week. Credit one hour.

ENGLISH.

Mr. Scott.

Efficiency in oral and in written expression on the part of the engineer is no longer considered among teachers in technical schools a matter of secondary importance. Efficiency in English, like that in any purely technical subject, can be acquired only by a systematic study of the principles underlying the subject, followed by long apprenticeship of practice under judicious criticism.

No credit for advanced standing in English will be given unless the work for which the credit is asked was done in the collegiate department of an accredited college or in the Junior or Senior year of a State normal school.

Courses.

1a. EXPOSITORY LITERATURE AND MECHANICS OF WRITING. *Lectures.* (Scott)

Lectures will be given in expository literature and mechanics of writing. The principles of each subject will be discussed, and selections from expository literature will be analyzed as to thought and style.

Short daily and long biweekly themes on expository subjects are required. This work is carefully criticised by the teacher, corrected by the student, and returned to the critic as evidence that the student has profited by the criticisms.

Prerequisites: Entrance requirements.

Required in I., II., III., IV., V., and VI.

Freshman year, first semester, five hours per week. Credit five hours.

Texts: Berkeley, *College Course in Writing from Models.*
Wooley, *Mechanics of Writing.*

1b. DESCRIPTIVE AND NARRATIVE LITERATURE AND MECHANICS OF WRITING. *Lectures.* (Scott)

This course is a continuation of English 1a. The theme work of the first semester is continued throughout the year.

Prerequisite: English 1a.

Required in I., II., III., IV., V., and VI.

Freshman year, second semester, five hours per week. Credit five hours.

3a. SCIENTIFIC AND EXPOSITORY LITERATURE. *Lectures.* (Scott)

The class work in this subject will be a critical study of present day, practical articles, which in thought and style are masterpieces.

Students in this course are required to write each month themes amounting to at least a thousand words. One of these themes must contain at least five hundred words. The subjects will be expository, and, as far as practicable, will be parallel with the specimens studied. The method of criticism will be that used in English 1a.

Prerequisites: English 1a and 1b.

Required in I., II., III., IV., and V.

Sophomore year, first semester, one hour per week. Credit one hour.

Text: Percival and Jelliff, *Specimens of Exposition.*
Addresses on Scientific Subjects.

3b. ARGUMENTATIVE LITERATURE. *Lectures.* (Scott)

This course is a continuation of English 3a, except that special attention is given to argumentative literature.

Themes are required as in English 3a, except that the subjects for themes are argumentative.

Prerequisite: English 3a.

Required in I., II., III., IV., and V.

Sophomore year, second semester, one hour per week. Credit one hour.

Text: Percival and Jelliff, *Argumentation.*
Addresses on Argumentative Subjects.

5a. EXPOSITION IN THEORY AND PRACTICE. *Lectures.* (Scott)

The class work will consist of the study of the underlying principles of expository literature and an analysis of the thought and style of selections from scientific and expository literature.

Triweekly and fortnightly themes on expository subjects will be required. The triweekly will be one hundred fifty word themes written in class. The fortnightly are five hundred word (or more) themes and are to be written out of class. The system of theme criticism for other courses will be used in this course.

Prerequisites: English 1a and 1b.

Required in VI.

Sophomore year, first semester, five hours per week. Credit five hours.

Texts: Baldwin, *College Rhetoric.*
Canby, *Composition in Theory and Practice.*
Addresses on Scientific Subjects.

5b. ARGUMENTATION, DESCRIPTION, AND NARRATION IN THEORY AND PRACTICE. (Scott)

This course is a continuation of English 5a with theme work.

Prerequisite: English 5a.

Required in VI.

Sophomore year, second semester, five hours per week. Credit five hours.

Texts: Thomas, *Manual of Debate.*
Canby, *Composition in Theory and Practice.*
Addresses on Argumentative Questions.

GEOLOGY AND MINERALOGY.

Assistant Professor Cox, Assistant Professor Eggleston,
Mr. McNutt.

Equipment.

The geological and mineralogical laboratories are on the second floor of Norwood Hall. They are supplied with suitable tables for the examination of rocks and minerals. The equipment of the department includes reference, working, and cabinet collections of minerals, ores, rocks, and fossils and many specimens illustrating metallurgical processes; a working collection of wooden and glass crystal models and natural crystals; full sets of maps and reports and a set of geologic relief models.

There is also a collection of thirty-five hundred specimens, representing the mineral wealth of Missouri, consisting of coal, clays of many sorts, and building stones, and ores of lead, zinc, iron, and copper. The minerals occurring as gangue with the metalliferous deposits of the State are also well represented. There is also a complete collection of the economic minerals of Missouri and a good economic geological collection representing the world at large. This collection was a part of the Missouri Mineral Exhibit displayed at the World's Fair at Chicago and was presented to the School of Mines and Metallurgy by the General Assembly in 1895.

In addition to the above-mentioned collection, the State Board of Equalization assigned to the School the specimens, models, maps, and machinery which constituted the Missouri Mining Exhibit at the St. Louis Exposition, thus giving to the School a large amount of valuable equipment.

The Museums contain crystals and minerals from various parts of the world, the important mining districts of the State of Missouri being especially well represented by the economic collection from Southwestern Missouri, the great geological relief map, polished stone tables and ornamental stones, and other complete collections of the Missouri Building of the St. Louis Exposition.

Rock breaking and section machines and instruments for geological surveys are included in the equipment of this department.

VIEW ON THE CAMPUS

Courses.

1a. MINERALOGY. *Lectures* and *Laboratory.*
(Eggleston, McNutt)

Elementary crystallography, including the study of models and natural crystals with oral and written recitations, eight weeks; practice in blowpipe analysis with determination of unknowns, six weeks; introduction to descriptive and determinative mineralogy the remainder of the semester. Recitations mostly oral.

Prerequisites: Chemistry 1a, 2a, 3b, 4b, and Shop Practice and Drawing 1a.

Required in I., II., III., IV., VI., and IX.

Sophomore year, first semester, two hours lectures and six hours laboratory per week. Credit four hours.

Texts: Patton, *Lecture Notes on Crystallography.*
Butler, *Handbook of Blowpipe Analysis.*
Dana, *Text-Book of Mineralogy.*

1b. MINERALOGY. *Lectures and Laboratory.*
(Eggleston, McNutt)

Descriptive and determinative mineralogy. A study of the fundamental principles of classification and the distinctive characters of minerals with a thorough drill in the recognition of about two hundred species. Recitations mostly oral.

Prerequisite: Geology and Mineralogy 1a.

Required in I., II., III., IV., VI., and IX.

Sophomore year, second semester, two hours lectures and six hours laboratory per week. Credit four hours.

Text: Dana, *Text-Book of Mineralogy.*

3a. GENERAL GEOLOGY. *Lectures.* (Eggleston)

Introductory structural and dynamic geology. A somewhat detailed account of geologic processes and structures. The larger topics are treated more exhaustively than in the required text.

Prerequisites: Geology and Mineralogy 1a and 1b.

Required in I., II., III., IV., V., VI., and IX.

Junior year, first semester, four hours per week. Credit four hours.

Text: Scott, *An Introduction to Geology.*

3b. GENERAL GEOLOGY. *Lectures.* (Eggleston)

An introduction to historical geology. Geologic history is traced from the beginning of the record to the present, as much attention as possible being paid to the rock-systems and their contained fos-

sils, with some reference to geographic changes and organic evolution.

Prerequisites: Geology and Mineralogy 3a. To be accompanied by Geology and Mineralogy 4b.

Required in I., II., III., IV., V., VI., and IX.

Junior year, second semester, four hours per week. Credit four hours.

Text: Scott, *An Introduction to Geology.*

4b. GENERAL GEOLOGY. *Laboratory.* (Eggleston)

Eight weeks laboratory study of topographic and geologic maps and sections with exercise in their construction; excursions and field practice in elementary geologic mapping the remainder of the semester.

Prerequisite: Geology and Mineralogy 3a. To accompany Geology and Mineralogy 3b.

Required in I., II., III., IV., V., VI., and IX.

Junior year, second semester, six hours per week. Credit two hours.

References: Hayes, *Handbook for Field Geologists.*
Geikie, *Outline of Field Geology.*

5b. LITHOLOGY. *Lectures* and *Laboratory.* (Cox, McNutt)

A study of the structure, texture, mineral and chemical composition, and the manner of formation and occurrences of igneous, sedimentary, and metamorphic rocks. This course is adequate for all general field determinations.

Prerequisites: Geology and Mineralogy 1a, 1b, and 3a.

Required in I., II., III., IV., and IX.

Junior year, second semester, one hour lecture and three hours laboratory per week. Credit two hours.

Text: Kemp, *Handbook of Rocks.*

7a. GEOLOGY OF THE UNITED STATES. *Lectures.*
(Eggleston)

A brief account of the broader physiographic and geologic features of the United States, with the geology of certain states in more detail. Written summaries of folios of the United States Geological Survey required of each student.

Prerequisites: Geology and Mineralogy 3b, 4b, and 5b.

Required in III., VII., and VIII.

Senior year, first semester, three hours per week. Credit three hours.

References: Powell, et al., *Physiography of the United States.*
Chamberlin and Salisbury, *Geology, Vols. II. and III.*
Publications of the United States and various State Geological Surveys.

9a. ECONOMIC GEOLOGY. *Lectures.* (Cox)

The first two weeks are spent in defining terms and in a general consideration of ore deposits. The remainder of the semester is devoted to the occurrence, origin, and distribution of the ores of lead, zinc, copper, and gold. A brief written summary of the history, stratigraphy, structure, ores, associated minerals, occurrence, and origin of the ores of each district is required of each student.

Prerequisites: Geology and Mineralogy 3b, 4b, and 5b.

Required in I., II., III., and IX.

Senior year, first semester, four hours per week. Credit four hours.

Text: No text required. Reference largely to reports by the United States and state geological surveys.

9b. ECONOMIC GEOLOGY. *Lectures.* (Cox)

A study of the occurrence, origin, and distribution of the ores of silver and iron, with a brief consideration of those of mercury, tin, nickel, cobalt, platinum, tungsten, and manganese. The remaining time is given to a discussion of the occurrence, origin, distribution, and commercial requirements of the non-metallic ores and products, coal, oil and gas, clays, cement, gypsum, phosphates, and building stones. A number of trips to points of economic interest are included in this course.

Prerequisite: Geology and Mineralogy 9a.

Required in I., II., III., and IX.

Senior year, second semester, four hours per week. Credit four hours.

Text: No text required. Reference largely to reports of the United States and state geological surveys.

11a. PETROGRAPHY. *Lectures* and *Laboratory.*
(Cox, McNutt)

The semester is devoted to the study of optics as applied to the determination of minerals by the polarizing microscope, the identification of minerals in thin sections, and the grinding of rock and mineral thin sections.

Prerequisites: Geology and Mineralogy 3b, 4b, and 5b, and Physics 3a and 4a.

Required in III. and VII.

Senior year, first semester, three hours lecture and nine hours laboratory per week. Credit six hours.

Text: Luquer, *Minerals in Rock Sections.*

11b. PETROGRAPHY. *Lectures* and *Laboratory.* (Cox, McNutt)

A study of nomenclature, relations, and alterations of rocks, together with the petrographic analysis and the recalculation of the chemical analyses of rocks.

Prerequisite: Geology and Mineralogy 11a.

Required in III. and VII.

Senior year, second semester, three hours lecture and six hours laboratory per week. Credit five hours.

Texts: Kemp, *Handbook of Rocks*, with one of the following:
Iddings, *Rock Minerals.*
Winchell, *Elements of Optical Mineralogy.*
Johannson, *Determination of Rock-Forming Minerals.*

13b. STRUCTURAL GEOLOGY. *Lectures.* (Cox)

A study of rock deformation, including a review of the theories of the origin of the earth; a discussion of the zones of rock fracture and rock flowage; a classification and discussion of cleavage, joints, faults, folds, autoclastic rocks, conglomerates, and pseudo-conglomerates; and a consideration of mountain building forces, together with the horizontal and vertical depth affected, with application to special districts.

Prerequisites: Geology and Mineralogy 3b, 4b, and 5b.

Required in III. and VII.

Senior year, second semester, three hours per week. Credit three hours.

14a. FIELD GEOLOGY. *Field Work.* (Cox)

The course consists of both field and laboratory work, the two being varied to suit the weather. The field work consists of the making of topographic and geologic maps, with suitable sections and reports, of assigned areas. The laboratory work includes the making of sections and maps and the final drafting of the field work.

Prerequisites: Geology and Mineralogy 3b, 4b, and 5b, and Civil Engineering 4.

Required in III.

Senior year, first semester, six hours per week. Credit two hours.

15b. GEOLOGY CONFERENCE. (Cox)

The conference consists of a discussion by the students and instructors of geologic problems and literature, each student being assigned certain work upon which he must report to the class.

Prerequisite: Geology and Mineralogy 9a.

Required in III.

Senior year, second semester, one hour per week. Credit one hour.

MATHEMATICS.

PROFESSOR DEAN, ASSISTANT PROFESSOR GARRETT, MR. GABA.

While the utility of mathematical study as a mental discipline is duly recognized, the ultimate intention of the student is kept in mind, and the matter and methods of the courses are adjusted, as nearly as possible, to meet the demands of subsequent studies and professional practice.

Courses.

1a. COLLEGE ALGEBRA. *Lectures.* (Dean, Gaba)

Theory of limits, logarithms, progressions, binomial theorem, undetermined coefficients, series and solution of higher equations. Special attention is paid to graphical solutions and practical applications.

Prerequisites: Entrance requirements.

Required in I., II., III., IV., V., and VI.

Freshman year, five hours per week, first twelve weeks. Credit three hours.

Text: Rietz and Crathorne, *College Algebra.*

3a. PLANE TRIGONOMETRY. *Lectures.* (Dean, Gaba)

Solution of plane triangles, reduction and transformation of trigonometric expressions, solution of trigonometric equations.

Prerequisite: Mathematics 1a.

Required in I., II., III., IV., V., and VI.

Freshman year, remainder of first semester after 1a. Credit two hours.

Text: Hall and Frink, *Trigonometry.*

5b. SPHERICAL TRIGONOMETRY. *Lectures.* (Dean, Gaba)

Continuation of Mathematics 3a, taking up more difficult parts of analytical trigonometry, solution of spherical triangles, and simpler problems of spherical astronomy.

Prerequisite: Mathematics 3a.

Required in I., II., III., IV., V., and VI.

Freshman year, second semester, first five weeks, five hours per week. Credit two hours.

Text: Hall and Frink, *Trigonometry.*

7b. ANALYTICAL GEOMETRY. *Lectures.* (Dean, Gaba)

The object of this course is to familiarize the student with methods rather than with any particular set of curves. Special attention, however, is given to those forms of the equations of the conic sections which occur in technical literature.

Prerequisite: Mathematics 5b.

Required in I., II., III., IV., V., and VI.

Freshman year, remainder of second semester after Mathematics 5b, five hours per week. Credit three hours.

Text: Ashton, *Analytic Geometry.*

9a. DIFFERENTIAL CALCULUS. *Lectures.* (Dean, Gaba)

The student is thoroughly drilled in the derivation of formula, and the application of derivatives in the solution of problems in maxima and minima, in curve tracing, velocity and acceleration, expansion of functions.

Prerequisite: Mathematics 7b.

Required in I., II., III., IV., and V.

Sophomore year, first twelve weeks of first semester, five hours per week. Credit three hours.

Text: Granville, *Calculus.*

11a, 11b. INTEGRAL CALCULUS. *Lectures.* (Dean, Gaba)

The student is drilled in the integration of forms occurring in mechanics and physics, in evaluating areas, moments, moments of inertia, in finding centers of gravity, center of stress, and in the derivation and application of fundamental formulae of hydrostatics and hydraulics.

Prerequisite: Mathematics 9a.

Required in I., II., III., IV., and V.

Sophomore year, five hours per week, after 9a, and first six weeks of second semester. Credit two hours on each semester.

Text: Granville, *Calculus.*

13b. DIFFERENTIAL EQUATIONS. (Dean)

Integrable forms of the differential equations of mechanics and physics, applications of partial differentiation and partial integration, theory of attraction, dynamics of a particle, and thermodynamics of perfect gases.

Prerequisites: Mathematics 11a and 11b.

Required in I., II., III., IV., and V.

Sophomore year, second semester, five hours per week. Credit three hours.

Text: Cohen, *Differential Equations.*
Dean, *Manuscript Notes.*

15a. GENERAL MECHANICS. *Lectures.* (Garrett)

It is the aim in this course to train the student to apply the essential principles of mechanics to the solution of practical rather than theoretical problems. The problems are selected from machines and structures with which the student is already familiar, or the study of which he is to take up subsequently.

Prerequisites: Mathematics 11a and 11b.

Required in I., II., III., IV., and V.

Junior year, first semester, four hours per week. Credit four hours.

Text: Hancock, *Applied Mechanics for Engineers.*
Dean, *Manuscript Notes.*

17b. MECHANICS OF MATERIALS. *Lectures.* (Garrett)

A study of the theory of stress, strain and elasticity and its application to the calculation of stresses and deformations in beams, shafts, columns, springs and plates, the design of members of structures and machines, and of re-enforced concrete and pillars.

Prerequisite: Mathematics 15a.

Required in I., II., III., IV., and V.

Junior year, second semester, three hours per week. Credit three hours.

Text: Houghton, *Elements of Mechanics of Materials.*

WATER-JACKET BLAST-FURNACE

METALLURGY AND ORE DRESSING.

PROFESSOR COPELAND, MR. DUDLEY, MR. MANN.

Equipment.

The assay laboratory has a floor space of forty-eight hundred square feet. In the main room are twenty coal-fired, double-muffle assay furnaces, twelve gasoline-fired muffle furnaces, and ten coke-fired furnaces. Desks containing lockers, pulp balances, and fluxes are arranged close to the furnaces.

A room 16 by 16 feet, separated from the furnace laboratory by glass partitions, is used for parting. There are in this room the necessary hot plates, acid jars, and annealing muffles. The desks in this laboratory are topped with white tiling.

The balance room is 20 by 20 feet and is lighted only from the north. It is easily kept at constant temperature. There are eleven balances suitable for weighing gold. A number of these balances have the multiple-rider attachment.

For chemical work in connection with metallurgy, there is a well-lighted room having fifty-six lockers and fifty-six desks. Each desk is provided with gas, compressed air, and water. There is in the room ample hood space; in fact, the laboratory has everything necessary for general chemical work.

There is, in the main furnace room, a circular water-jacket blast furnace, 20 inches in diameter at the tuyeres, and 7-foot smelting column. This furnace is used for lead and copper smelting. For roasting ores a hand reverberatory furnace, with a hearth 4½ by 9 feet, is provided. This laboratory contains also an experimental pot roaster, an experimental zinc distilling furnace, three Le Chatlier thermo-electric pyrometers, and a Wänner optical pyrometer.

A stock room, containing chemicals, clay goods, glassware, and other supplies, serves all the laboratories. The ore-sample room is especially well equipped. It contains more than 1,000 samples of ore of varied classes. Each sample is stored away in paper sacks, all ready for issuing to the students. Each sample has been prepared and carefully assayed. Enough of each lot of ore has been prepared to give 200 to 300 samples of the same lot. The sample room, therefore, contains more than 1,000 different samples of ore, each sample being divided into 200 or more smaller samples, each of the smaller samples being ready for immediate issue.

Throughout the metallurgical and ore-dressing laboratories care has been taken that each furnace, each piece of apparatus, should be so arranged as to be fitted best for that testing work which must be so great a part of the students' work. In all the laboratory work, in addition to demonstrating the theories and principles explained in the class room, the attempt is made to give the man ability to do a day's work and to teach him to use both his head and his hands.

The main floor of the new ore-dressing laboratory occupies a space of forty-eight hundred square feet and a mezzanine floor provides an additional space of thirteen hundred square feet. The equipment of the laboratory is as follows: The crushing and sampling department contains a gyratory breaker, a Dodge breaker, a pair of 9-in. by 12-in. rolls, two plane shaking screens, two Vezin samplers, two bucket elevators, three belt conveyors, and six ore storage bins, each equipped with an automatic feeder. For fine crushing and amalgamation tests are provided a three-stamp mill, with amalgamated plates, and a 3½-ft. Huntington mill.

Ores are prepared for concentration by the following series of machines: Three trommel screens, a duplex Callow traveling belt screen, a Richards pulsator classifier, a four-spigot Richards vortex classifier, a three-spigot cone classifier, a small Tamarack classifier, and four Callow settling cones.

Methods of concentrating coarsely crushed ores are illustrated by three five-cell differential motion Harz jigs, a Richards pulsator jig, and a small model of the Hancock jig. Sands are treated on two laboratory-size Wilfley tables, one laboratory Card table, and one laboratory James table. A four-foot Frue vanner and a five-foot Sperry slimer are provided for the treatment of fine materials.

Two direct-connected motor-driven centrifugal sand pumps are used for elevating finely crushed ore to the screening and classification system.

The sample finishing room contains a small Blake crusher, a disc grinder, a coffee mill, a pair of rolls, a number of bucking boards and mullers, a laboratory tube mill, and an electric sample dryer.

The cyanide unit contains a laboratory leaching plant with all necessary tanks, a 16-in. Hendryx clay agitator, a 14-in. Hendryx combination agitator and filter, and a six-leaf 12-in. by 12-in. filter press.

Ores suited to magnetic concentration are treated on a Knowles magnetic separator, and for the preparation of such ores a cylindrical dryer and roaster, together with a plane impact screen for dry sizing, is provided.

Throughout the mill, wherever possible, the practice of driving each machine with an individual motor has been followed.

It is recognized that a school cannot give students, in the brief

time at its disposal, that skill which comes from long practice, but it is the aim to give such training in the fundamental principles and their application that students may become useful immediately on their entrance into the actual practice of their chosen profession. All metallurgical courses are accompanied by graded metallurgical problems.

An important feature of the instruction is experimental investigation in the metallurgical treatment of various ores.

Courses.

1a. FIRE ASSAYING. *Lectures.* (Mann)

This course deals with the theory of fire assaying as practiced in the laboratory. The points discussed are outlined under Metallurgy 2b.

Prerequisites: Chemistry 1a and 2a.

Required in I., II., III., IV., and IX.

Junior year, first semester, two hours per week. Credit two hours.

Texts: Lodge, *Notes on Assaying.*
Fulton, *Assaying.*

2b. or 2a. FIRE ASSAYING. *Laboratory.* (Mann)

This work includes the assay, by scorification and crucible methods, of ores from the various districts of the United States. Copper ores, copper mattes, and copper bullions are assayed by fire and by the combination method. Lead ores and furnace products are assayed for lead and for gold and silver. Assays of cyanide solutions, of zinc-box residues, of silver bullion, of gold bullion, of lead bullion, and of silver-mill precipitate, are included in this course. During the course the student has practice with coal furnaces, coke furnaces, and gasoline furnaces. Besides doing the ordinary work of assaying, the student studies the losses occurring. He learns the effects of different schemes of firing the furnaces by making analyses of the flue gases and by pyrometric measurements. The laboratory is so arranged that even with large classes a student is not hampered by other students and he learns to handle a large amount of work with the best utilization of his time.

Prerequisites: Chemistry 1a and 2a. To be preceded or accompanied by Geology and Mineralogy 1a.

Required in I., II., III., IV., and IX.

Junior year, second semester, nine hours per week. Credit three hours.

Texts: Lodge, *Notes on Assaying.*
Fulton, *Assaying.*

3b. GENERAL METALLURGY AND METALLURGY OF IRON.
(Copeland)

This course begins with general principles, including properties of metals and alloys, fuels, fluxes, calculation of charges, general study and classification of furnaces, followed by a study of processes employed for the production of cast iron, wrought iron, and steel.

Prerequisites: Chemistry 3b and 4b, Geology and Mineralogy 1b, Metallurgy 1a.

Required in I., II., III., IV., V., and IX.

Junior year, second semester, three hours per week. Credit three hours.

Texts: Campbell, *Manufacture and Properties of Iron and Steel.*
Stoughton, *Iron and Steel.*
Fulton, *Principles of Metallurgy.*

References: Roberts-Austen, *Introduction to the Study of Metallurgy.*
Howe, *Iron, Steel and Other Alloys.*

5a. METALLURGY OF THE NON-FERROUS METALS. *Lectures.*
(Copeland)

This course covers the metallurgy of lead, silver, copper, gold, zinc, nickel, mercury, tin, and antimony.

Metallurgy of Lead and Silver.—The properties and uses of lead, and of its alloys and compounds, are discussed in this course. A study is made of the principles and practice of sampling and purchasing ores. The major part of the course is given to the consideration of the standard and proposed methods for winning, desilverizing, and refining lead. Great stress is laid on the principles involved, and the student is referred to the text and to current literature for the details of processes. The winning of silver by smelting, amalgamation, and leaching is studied. Especial attention is given to cyaniding of silver ores. Throughout the course there is brought forward the commercial view-point as well as the views strictly technical.

Texts: Hofman, *Metallurgy of Lead.*
Collins, *Metallurgy of Silver.*

Metallurgy of Copper, Nickel, Mercury, Tin, Antimony.—The metallurgy of copper is the principal part of the course. The lectures deal with the properties and uses of the copper and copper products and with the principles employed in the winning and refining of copper.

The metallurgy of nickel, mercury, tin, and antimony is each discussed only briefly.

Text: Peters, *Principles of Copper Smelting.*

Metallurgy of Gold and Zinc.—The extraction of gold by the standard methods is considered. Especial attention is given to cyaniding. The rapid advances in cyanide practice are discussed in the class room, and laboratory experiments on debated points are encouraged.

The course in the metallurgy of zinc includes lectures on the properties of zinc and its compounds, the concentration of zinc ores, and the manufacture of spelter and of zinc paints.

Texts: Rose, *Metallurgy of Gold.*
Ingalls, *Metallurgy of Zinc.*

Prerequisites: Metallurgy 3b and Chemistry 6b.

Required in I., III., IV., and IX.

Senior year, first semester, four hours per week. Credit four hours.

5b. METALLURGY OF THE NON-FERROUS METALS. *Lectures.* (Copeland)

This is a continuation of Metallurgy 5a.

Prerequisites: Metallurgy 3b and Chemistry 6b.

Required in I., IV., and IX.

Senior year, second semester, four hours per week. Credit four hours.

6a. METALLURGY. *Laboratory.* (Copeland, Mann)

This course covers the testing of ores for process treatment. Ores are tested by cyaniding, chlorination, amalgamation, lixiviation, concentration, and by combination methods. With aid of smelter schedules, the smelting costs are calculated and the net dollars and cents returns are balanced against the best results by any method, or combination of methods, worked out in the laboratory. The endeavor is made, not only to teach metallurgical principles in the laboratory, but also to bring home to the student the great effect that freight rates and such other factors have on the treatment which an ore should receive. Experiments are made in the reverberatory and "pot" roasting of ores, and on blast-furnace smelting of ores. Furnace heat equations are made by each student from data collected by himself.

Prerequisites: Metallurgy 1a, 2b, and 3b.

Required in I., III., IV., and IX.

Senior year, first semester, four hours per week in Curriculum I. Credit one hour.

Senior year, first semester, seven hours per week in Curriculum IV. Credit two hours.

Text: Howe, *Metallurgy Laboratory Experiments.*

7a. ALLOYS AND METALLOGRAPHY. *Lectures.* (Dudley)

These lectures deal with the theoretical and practical considerations that influence the structure and properties of alloys of different types.

Prerequisites: Chemistry 7a, Metallurgy 3b.

Required in IV.

Senior year, first semester, two hours per week. Credit two hours.

8a. ALLOYS AND METALLOGRAPHY. *Laboratory.* (Dudley)

This laboratory course is given in connection with the lectures, and deals chiefly with the micro-structure of iron and steel.

Prerequisites: Chemistry 7a, Metallurgy 3b.

Required in IV.

Senior year, first semester, three hours per week. Credit one hour.

9b. ELECTRO-METALLURGY. *Lectures.* (Dudley)

Lectures are given covering the electro-metallurgical processes that are in use. Efficiency and engineering calculations based on these processes are given.

Prerequisites: Metallurgy 3b, Physics 1b and 3a, Chemistry 9a, 10a, and 7a.

Required in IV.

Senior year, second semester, five hours per week. Credit five hours.

10b. ELECTRO-METALLURGY. *Laboratory.* (Dudley)

This course gives a study of the principles of electro-metallurgy from the standpoint of experiments actually performed. Tests are made on the electrolytic refining of copper and of lead bullion. Experiments are performed and calculations as to efficiency are made on electric smelting.

Prerequisites: Physics 1b and 3a, Chemistry 9a, 10a, and 7a. Accompanied by Metallurgy 9b.

Senior year, second semester, six hours per week. Credit two hours.

11a. METALLURGICAL ORGANIZATION. *Lectures.* (Copeland)

The course briefly takes up the principles of organization and the duties of officers and accounting force of a metallurgy plant. The outline shows the extent of the course. Organization of companies and working forces, management, superintendence, skilled

and unskilled labor. Then, following this, the constitution of capital, stocks, bonds, dividends, and profits.

Prerequisite: Metallurgy 3b.

Required in IV.

Senior year, first semester, two hours per week. Credit two hours.

Text: Conyngton, *Corporate Management.*

13a. METALLURGY PROBLEMS. (Copeland)

These problems aim to cover the common ones that the metallurgist meets in practice.

Prerequisite: Metallurgy 3b. To accompany Metallurgy 5a.

Required in IV. and VII.

Senior year, first semester, one hour per week. Credit one hour.

Text: Richards, *Metallurgy Calculations.*

15b. METALLURGICAL MEMOIRS. *Lectures.* (Copeland)

The student in the Metallurgy Curriculum is required to do a considerable amount of technical reading in German and English. Carefully prepared abstracts of valuable current articles are presented and read by each student.

Prerequisite: Metallurgy 5a.

Required in IV.

Senior year, second semester, one hour per week. Credit one hour.

17a. METALLURGY CONFERENCE. *Lectures.* (Copeland)

The lectures cover the work being given at the time in the laboratory in Metallurgy 6a.

Prerequisite: Metallurgy 3b. To accompany Metallurgy 6a.

Required in I., IV., and IX.

Senior year, first semester, one hour per week. Credit one hour.

19a. METALLURGY PLANT. *Lectures.* (Copeland)

The arrangements of various metallurgical works are studied. The advantages and disadvantages of different equipments are given.

Prerequisites: Metallurgy 3b, 5a, and 5b.

Required in VIII.

Graduate course, first semester, two hours per week. Credit two hours.

20a. METALLURGY PLANT DESIGN. *Laboratory.*
(Copeland)

This is a drafting-room course, and the student is given problems to solve in detail, covering a part of the class-room discussions. Each student is required to submit complete drawings, specifications, and estimations of cost.

Prerequisites: Shop Practice and Drawing 2b, Metallurgy 3b, 5a, and 5b.

Required in VIII.

Graduate course, first semester, six hours per week. Credit two hours.

21a. CYANIDING. *Lectures.* (Mann)

This course teaches the principles and practice of cyaniding. The student keeps up with the progress in the art. Attention is given in all the work to the cost of operation and to the schemes used and proposed for lessening the cost. A detailed study is made of the types of filter presses, crushing machinery, and other devices used in cyanide mills. Cyaniding is compared with other possible methods of treatment.

Prerequisites: Metallurgy 1a, 2b, and 3b.

Required in VIII.

Graduate course, first semester, four hours per week. Credit four hours.

22a. CYANIDE LABORATORY. (Mann)

The student in this course has an opportunity to test in the laboratory the methods discussed in the class room. The work is not routine, but the experiments are arranged to bring out a point under discussion, or to solve, if possible, the problems occurring at the time in the class room.

Prerequisites: Metallurgy 1a, 2b, and 3b. To accompany Metallurgy 21a.

Required in VIII.

Graduate course, first semester, six hours per week. Credit two hours.

22b. CYANIDE LABORATORY. (Mann)

This course is a continuation of Metallurgy 22a.

Prerequisite: Metallurgy 22a.

Required in VIII.

Graduate course, second semester, six hours per week. Credit two hours.

23b. ORE SUPPLY. *Lectures.* (Copeland)

This course is intended to bring out the important subject of ore, flux, and fuel supplies. The subject is studied from a combined commercial and technical standpoint. The problems of valuing fluxes and fuels, of mixing ores so that the mixture shall command the lowest treatment rate, and of preparing, from the reduction works standpoint, treatment charges for different classes of ores, are studied.

Prerequisites: Metallurgy 5a and 5b.

Required in VIII.

Graduate course, second semester, two hours per week. Credit two hours.

25a. METALLURGICAL RESEARCH. *Laboratory, Reading, and Conferences.* (Copeland)

Each graduate student elects a subject for special study. It is recommended that the work be along a different line from the subject chosen for thesis. The course consists principally of assigned reading, together with conferences with the professor on the matter read. The laboratories are always open for the solving of any problem that may arise.

Prerequisites: Metallurgy 5a and 5b.

Required in VIII.

Graduate course, first semester, five hours per week. Credit five hours.

25b. METALLURGICAL RESEARCH. *Laboratory, Reading, and Conferences.* (Copeland)

This course is a continuation of Metallurgy 25a.

Prerequisite: Metallurgy 25a.

Required in VIII.

Graduate course, second semester, five hours per week. Credit five hours.

27b. ADVANCED METALLURGICAL PROBLEMS. *Lectures.* (Copeland)

This course has reference to the designing and proportioning of various types of furnaces for special duties and conditions.

Prerequisite: Metallurgy 13a.

Required in VIII.

Graduate course, second semester, two hours per week. Credit two hours.

31b. ELEMENTS OF ORE DRESSING. *Lectures.* (Dudley)

In this course the principles of all common ore-dressing processes are briefly discussed. The various machines used for crushing, classification, and concentration of ores are described. Especial attention is given to those processes and mill schemes which the student has opportunity to see while on the Junior trip.

Prerequisites: Mathematics 15a, and Mineralogy and Geology 1b.

Required in I., II., III., IV., and IX.

Junior year, second semester, two hours per week. Credit two hours.

Text: Richards, *Text-Book of Ore Dressing.*

33a. ORE DRESSING. *Lectures.* (Dudley)

In this course the principles of mechanical ore treatment are discussed in detail. The construction and theory of machines are presented in lectures, supplemented by a full equipment of models, which show the design of all common ore-dressing appliances. The latter part of the course deals with the management of mills and with the adaptation of processes to the successful treatment of various ores.

Prerequisite: Metallurgy 31b.

Required in I., II., III., IV., and IX.

Senior year, first semester, four hours per week. Credit four hours.

Text: Richards, *Text-Book of Ore Dressing.*

33b. ORE DRESSING. *Lectures.* (Dudley)

This course is a continuation of Metallurgy 33a.

Prerequisite: Metallurgy 33a.

Required in I., II., III., IV., and IX.

Senior year, second semester, four hours per week. Credit four hours.

Text: Richards, *Text-Book of Ore Dressing.*

34a. ORE DRESSING PROBLEMS. *Laboratory.* (Dudley)

In this course advanced work is given in connection with the design of plants and machinery for the treatment of ores. The course includes the determination of a practical process for treating a given ore, and the design of a mill for utilizing this process.

Prerequisites: Metallurgy 1a, 2b, and 31b, Shop Practice and Drawing 2b. To be accompanied by Metallurgy 33a.

Required in I., IV., and IX.

Senior year, first semester, three hours per week. Credit one hour.

ORE DRESSING BUILDING

36b. ORE DRESSING LABORATORY. (Dudley)

The student becomes familiar with the operation and care of milling machinery by actual laboratory experience. All types and classes of machines are available to illustrate principles and practice as presented in the lecture work. The laboratory is so arranged that a number of mill schemes may be utilized and processes for treating a particular ore can be determined from mill tests on large quantities of the ore.

Prerequisites: Metallurgy 1a, 2b, and 33a. To be accompanied by Metallurgy 33b.

Required in I., III., IV., and IX.

Senior year, second semester, six hours per week. Credit two hours.

MINING.

Director Young and Professor Forbes.

Equipment.

The surveying equipment already referred to in Civil Engineering is used for mine surveying. The School of Mines has several thousand drawings and blue-prints of mining machinery and mine plants which are used in connection with work in mining and mine management. There are also in the Library a large number of lantern slides and photographs illustrating mining practice in the United States.

The laboratories contain air compressors, pumps, rock drills, special drill steel, and models of mine timbering, which are used for demonstration and experimental work.

Courses.

1b. MINING. *Lectures.* (Forbes)

This course outlines the principles on which the science of Mining Engineering is founded, and is designed to introduce the student to fundamentals which will enable him to appreciate the application of the other studies of the Freshman and Sophomore years.

Prerequisites: Entrance requirements.

Required in I., II., III., IV., V., and VI.

Freshman year, second semester, two hours per week. Credit two hours.

3a. MINING. *Lectures.* (Forbes)

This course includes lectures on prospecting, drilling, blasting, tunneling, shaft sinking, and mining methods, also mine haulage, hoisting, drainage, ventilation, accidents, and hygiene. The various tools and appliances used in mining operations are described, and a review of methods of mine timbering is included in the course.

Prerequisite: Mining 1b.

Required in I., II., III., V., and IX.

Sophomore year, first semester, three hours per week. Credit three hours.

Text: Crane, *Ore Mining Methods.*

5b. MINE SURVEYING. *Lectures.* (Forbes)

The theory and the practice of the surveying of mineral lands and mines are presented by lectures. Many problems are introduced and the student is trained in various calculations, including the reduction of notes of underground surveys requiring the auxiliary telescope, volumes of stopes, mineral acreage, intersection of veins, underground connections, and the general problems in the determination of the location of mine openings. A mine surveying trip to Joplin or other mining district is a required part of the work of the Junior year.

Prerequisites: Civil Engineering 1a and 2a.

Required in I., II., III., V., and IX.

Sophomore year, second semester, two hours per week. Credit two hours.

6. JUNIOR TRIP.

At the end of the school year the members of the Junior class make a three weeks' trip, either to the mining districts of Southwest Missouri or to Colorado and Utah. The purpose of the trip is to give an opportunity for the study of the methods of mining and concentration of ores in the districts visited, together with work in mine surveying and geology.

Prerequisites: Mining 5b, Geology 3b, and Metallurgy 31b.

Required in I., II., III., IV., and IX.

Junior year, Summer session. Credit three hours.

7a. MINING LAW. *Lectures.* (Young)

The general principles of mining law are reviewed with discussion of legal decisions in representative cases. The students are given the general principles governing the making of contracts, together with discussion of contracts typical of various mining districts.

Prerequisites: Mining 3a, Geology 3a and 3b.

Required in I., II., III., IV., and IX.

Senior year, first semester, one hour per week. Credit one hour.

9b. MINE MANAGEMENT. *Lectures.* (Young)

This course is planned to give the student an idea of the principles of management of mining enterprises, and reviews methods of mine organization and mine accounting. Economic problems in connection with mine management are presented. The practice of mine examination and mine reporting is reviewed.

Prerequisites: Mining 5b and 7a.

Required in I., II., III., and IX.

Senior year, second semester, two hours per week. Credit two hours.

Texts: Rickard, *Economics of Mining.*
Rickard, *Ore Sampling.*

11a. COAL MINING MACHINERY. *Lectures.* (Forbes)

This course includes an outline of the various types of machinery used in mining operations and is planned to familiarize the student with the best designs of machinery in order that he may be able to select the proper machine for the particular condition. The machinery studied includes rock-drills, coal-cutters, mine-hoists, mine-pumps, mine-locomotives, wire-rope haulage systems, mine-fans, and safety appliances.

Prerequisite: Mining 5b.

Required in II. and VII.

Senior year, first semester, two hours per week. Credit two hours.

13a. COAL MINE VENTILATION. *Lectures.* (Young, Forbes)

This course includes a study of the various gases met with in mines, their origin, effects, and detection; the amount of fresh air required for men and animals under varying conditions; natural and artificial means of ventilation; gas and dust explosions and mine rescue work. A large part of the course is devoted to problems in mine ventilation.

Prerequisites: Mining 11a, and Physics 1b.

Required in II. and VII.

Senior year, first semester, two hours per week. Credit two hours.

14a. COAL MINE SURVEYING AND MAPPING. *Laboratory.* (Forbes)

This course is supplementary to Mining 5b and 6 and is designed to familiarize the student with methods of coal mine surveying and mapping. A complete survey and map of some coal mine designated by the instructor is required.

Prerequisite: Mining 6.

Required in II.

Senior year, first semester, six hours per week. Credit two hours.

15b. COAL MINING METHODS AND OPERATION. (Young, Forbes)

The details of various methods of developing and mining coal seams are studied in this course, and advantages and disadvantages

of methods as applied to beds of different character are considered. Coal mining practice in various districts is discussed and a detailed study is made of a number of mine plants. The course also includes a consideration of the economics of coal mining.

Prerequisite: Mining 13a.

Required in II. and VII.

Senior year, second semester, four hours per week. Credit four hours.

16b. FUEL TESTING. *Laboratory.*

In this course the student is required to test the calorific power of different coals by burning them under a boiler or in a gas producer. Analyses of coals tested are made and also tests as to their coking qualities.

Prerequisite: Mining 15b.

Required in II.

Senior year, second semester, six hours per week. Credit two hours.

17b. METHODS OF PROSPECTING AND MINE DEVELOPMENT. *Lectures.* (Forbes)

This short course is given to students who are specializing in mining geology, as the work of the mining geologist often involves the superintending of prospecting operations and the planning of methods of developing ore bodies. Special attention is paid to both churn and diamond drilling, and the adaptability of each to prospecting of different kinds of deposits is carefully considered.

Prerequisites: Mining 5b and 7b, and Geology 9a.

Required in III.

Senior year, second semester, one hour per week. Credit one hour.

Graduate Courses.

18a, 18b. MINE PLANT DESIGN. *Laboratory.* (Forbes)

This is a drafting-room course and is supplementary to all the previous mining courses. Each student is required to prepare complete drawings for the equipment of a given mine. Bills of material, specifications, and complete estimates are submitted.

Prerequisites: Mining 9b and Civil Engineering 13a.

Required in VII.

Graduate course, first and second semesters, three hours per week. Credit two hours.

19a. MINING ECONOMICS. *Lectures.* (Young, Forbes)

Various economic problems of interest to mining engineers are studied. The influence of mining in the history of America and especially in United States history is reviewed and the relation of mining to other industries is considered. The organization of the mining industry, the conservation of the mineral resources, and various problems in economics, including mining labor, wages, capital, taxation, profit-sharing, and employers' liability are presented by lectures and assigned reading.

Prerequisites: Mining 9b, Geology 9a.

Required in VII. and VIII.

Graduate course, first semester, one hour per week. Credit one hour.

MODERN LANGUAGES.

MR. WILKINS.

The great quantity and worth of the technical literature in the French and German languages, added to their value as elements of liberal culture, make at least a reading knowledge of them practically a necessary part of an engineer's education.

The instruction in each language is designed to present the grammatical structure and the pronunciation of the tongue, to give some acquaintance with the masterpieces of its literature, and to confer such facility in translation as will enable the student to read with ease the language in both its literary and its scientific uses.

All candidates for degrees in Mining Engineering, Metallurgy, and Civil Engineering are required to complete one year's work in Modern Language. They may elect 3a and 3b, 5a and 5b, or 7a and 7b.

Courses.

1a. ELEMENTARY GERMAN. (Wilkins)

To accommodate students who elect German as a foreign language in their course and who have not had at least one year of high school German.

Prerequisites: Entrance requirements.

Freshman year, first semester, three hours per week.

1b. ELEMENTARY GERMAN. (Wilkins)

This course is a continuation of Modern Language 1a.

Prerequisite: Modern Language 1a.

Freshman year, second semester, two hours per week.

3a. SCIENTIFIC GERMAN. (Wilkins)

Prerequisites: Modern Language 1a and 1b.

Required in VI.

Sophomore year, first semester, five hours per week. Credit five hours.

Text: Dippold, *Scientific German Reader.*
Current Scientific Journals and Magazines.

3b. SCIENTIFIC GERMAN. (Wilkins)

This course is a continuation of Modern Language 3a.

Prerequisite: Modern Language 3a.

Required in VI.

Sophomore year, second semester, five hours per week. Credit five hours.

Text: Dippold, *Scientific German Reader.*
Current Scientific Journals and Magazines.

5a. FRENCH (SCIENTIFIC). (Wilkins)

Students who have not had Elementary French will not be permitted to elect this language.

Prerequisite: Elementary French.

Sophomore year, first semester, five hours per week. Credit five hours.

Text: Herdler, *Scientific French Reader.*
Current Scientific Journals and Magazines.

5b. FRENCH (SCIENTIFIC). (Wilkins)

This course is a continuation of Modern Language 5a.

Prerequisite: Modern Language 5a.

Sophomore year, second semester, five hours per week. Credit five hours.

Text: Herdler, *Scientific French Reader.*
Current Scientific Journals and Magazines.

7a. SPANISH. (Wilkins)

The growing demand for mining engineers and metallurgists in South and Central America, in Mexico and in the Philippines, where a knowledge of Spanish is almost an essential qualification, has been met by the establishment of a course in this language in the School of Mines. The natural or conversational method is followed exclusively. The object is to give the student facility in the everyday speech of the people. Students may elect Spanish as the required modern language.

Prerequisites: English 1a and 1b.

Sophomore year, first semester, five hours per week. Credit five hours.

Text: Hill and Ford, *Spanish Grammar.*

7b. SPANISH. (Wilkins)

This course is a continuation of Modern Language 7a.

Prerequisite: Modern Language 7a.

Sophomore year, second semester, five hours per week. Credit five hours.

Text: Umphrey, *Spanish Prose Composition.*

PHYSICS.

Professor McRae, Mr. Bingham.

Equipment.

The lecture room and laboratories for Physics and Electricity are in Norwood Hall. The lecture room will seat one hundred students and is provided with water, gas, and electric connections for conveniences in lecture demonstrations and experiments.

The physical laboratory is on the ground, or basement, floor. There are two large laboratories, one equipped for general physical measurements in mechanics, sound, and heat, and one equipped for electric measurements. There is a battery room equipped with both primary and secondary batteries connected by wires with the various laboratories and the lecture room; a constant-temperature room with double walls and air space insulation; a commodious dark-room with blackened walls for spectrometric and photometric measurements, and a special laboratory for research work.

The equipment includes a Rowland electro-dynamometer with shunts and resistances; a Leeds & Northrup decade wheatstone bridge; a Queen & Co. postoffice pattern wheatstone bridge; two portable testing sets; various wheatstone bridges and resistance boxes; standards of resistance, inductance and capacity; a Lummer-Brodhun photometer; a Gaertner dividing engine, with linear and circular attachments; a Threlfall micromanometer; a Duddell thermo galvanometer; various tangent, mirror and D'Arsonval galvanometers; a Parr coal calorimeter; a wireless telegraph demonstration set; a ten-inch induction coil; Crooke's tubes; X-ray tubes; Toepler Holtz machine; a Schmidt & Haensch spectrometer; a Rowland diffraction grating; photographs of Rowland's normal solar spectrum; Crosby, and Schaeffer and Budenberg steam and gas engine indicators; Amsler planimeters; tachometers and speed counters; various balances; micrometers, calipers, together with apparatus for illustrating the principles of physics.

The dynamo laboratory contains an assortment of direct-current generators and motors, a General Electric double-current generator for direct current and alternating current work, a single and a three-phase generator, an induction motor, a single-phase repulsion motor, a rotary transformer, stationary transformers, three-phase to two-phase transformers, and a Cooper-Hewitt mercury vapor con-

verter, testing instruments, which include a Weston laboratory standard voltmeter, with multipliers; a Weston laboratory standard milli-voltmeter, with shunts; a Kelvin electrostatic voltmeter; Weston portable direct current ammeters; Weston portable direct current and alternating current voltmeter; Weston and Thomson portable wattmeters; Thomson alternating current voltmeters; Westinghouse portable polyphase wattmeter; Westinghouse portable voltmeter with transformer; Westinghouse portable ammeter with series transformer; electro-dynamometers; a Grassot fluxmeter; inductance coils, and condensers.

The power plant also is used for experimental purposes, and comprises a strictly modern and thoroughly equipped laboratory. The machinery available for testing purposes includes three 130-h. p. Heine safety boilers. The steam engines include a 75-h. p. Ideal engine, a 35-h. p. Brownell engine, and a 7-h. p. Davis & Rankin vertical engine. A 21-h. p. Otto gas engine may be belted to electric generators or used for experimental purposes. The pneumatic equipment includes a Laidlaw-Dunn-Gordon air compressor, a Rand Imperial type air compressor, a 72-inch ventilating fan, a 36-inch ventilating fan, and a 60-inch Buffalo forge blower. There are six pumps of three different patterns, which can be used for power or experimental purposes. The electric generators include a 50-kw. Westinghouse 220-volt direct-current generator, a 3½-kw. 120-volt generator, a 15-kw. General Electric 220-volt interpole direct-current generator, a 7½-kw. General Electric direct and alternating-current generator, a 2-kw. three-phase Westinghouse generator, and a 1-kw. Westinghouse single-phase generator.

The various electrical motors used for power purposes in the shops and laboratories are available for testing in addition to the machinery in the dynamo laboratory. The total electrical equipment includes thirty-five motors, varying in size from ½-h. p. to 35-h. p., with the aggregate rating of 225-h. p.

Courses.

1b. GENERAL PHYSICS. *Lectures.* (McRae)

The work in general physics begins with the study of kinematics, statics, kinetics, and the mechanics of fluids. The term's work concludes with the study of heat, including an introduction to thermodynamics. Particular attention is paid to harmonic motion as the basis for the study of such subjects as sound, light, and alternating currents of electricity.

Prerequisites: To be preceded by or accompanied by Mathematics 9a, 11a, and 11b.

Required in I., II., III., IV., and V.

Sophomore year, second semester, four hours per week. Credit four hours.

Text: Watson, *General Physics.*

2b. GENERAL PHYSICS. *Laboratory.* (McRae, Bingham)

The laboratory is quantitative, and aims, as far as possible, to instruct the student in the methods of physical measurement and the derivation of relations between the quantities measured. Emphasis is laid upon the derivation of physical laws rather than the verification of them.

Prerequisite: Mathematics 7b.

Required in I., II., III., IV., V., and VI.

Sophomore year, second semester, one afternoon per week. Credit one hour.

3a. GENERAL PHYSICS. *Lectures.* (McRae)

This is a continuation of course 1b and includes the study of electricity and magnetism, sound and light. Particular stress is laid upon electrical potential, resistance, and impedance; and upon the reflection, refraction, and interferences of waves. Lectures, illustrated by experiments, and recitations.

Prerequisites: To be preceded by or accompanied by Mathematics 9a and 11a.

Required in I., II., III., IV., V., and VI.

Junior year, first semester, four hours per week. Credit four hours.

Text: Watson, *General Physics.*

4a. GENERAL PHYSICS. *Laboratory.* (McRae, Bingham)

The work in the laboratory deals with the subjects studied in Physics 3a and the method is the same as that outlined in Physics 2b.

Prerequisite: To be accompanied by Physics 3a.

Required in I., II., III., IV., V., and VI.

Junior year, first semester, two afternoons per week. Credit two hours.

5a. THERMODYNAMICS. *Lectures.* (McRae)

A short course in theoretical thermodynamics is followed by a study of boilers, furnaces, and heat engines, standard types of safety and tubular boilers, chimney and mechanical draft, pumps and heaters. Steam, gas, and gasoline engines are also studied.

Prerequisites: Mathematics 9a, 11a, and 11b, and Physics 1b.

Required in I., II., III., IV., and V.

Junior year, first semester, three hours per week. Credit three hours.

Texts: Reeve, *Thermodynamics.*
Marks and Davis, *Steam Tables.*

6a. STEAM LABORATORY. (McRae, Bingham)

Practice is had in operating and indicating steam and gas engines, measuring chimney draft, combustion products, and the calorific value of fuels.

Prerequisite: To accompany Physics 5a.

Required in I., II., III., IV., and V.

Junior year, first semester, three hours per week. Credit one hour.

7a, 7b. ELECTRICAL MACHINERY. *Lectures.* (McRae)

This course discusses the magnetic circuit of dynamos and motors, methods of testings and connections for operation of direct current dynamos and motors, of single and polyphase alternating current generators, of induction and synchronous motors, of stationary transformers and rotary converters, and the effects of frequency, resistance, inductance and capacity upon the impedance of alternating current circuits. During the latter part of the course, the design of electrical transmission lines is studied, accompanied by the analytical and graphical solution of practical problems.

Prerequisites: Physics 1b and 3a.

Required in I., II., IV., and V.

Senior year, first and second semesters, three hours per week. Credit six hours.

Texts: Sheldon and Hausmann, *Dynamo Electrical Machinery.*
Sheldon, Mason, and Hausmann, *Alternating Current Machines.*
Pender, *Principles of Electrical Engineering.*

8a, 8b. DYNAMO LABORATORY. (McRae, Bingham)

This course accompanies course 7a, 7b and consists of calibration of instruments, measurements of ohmic and reactive resistances, insulation resistance and dielectric strength, regulation and efficiency tests of dynamos, motors, transformers, and converters.

Prerequisites: Physics 1b and 3a.

Required in I., II., IV., and V.

Senior year, first semester, two afternoons per week; second semester, one afternoon per week. Credit, 8a two hours, 8b one hour.

9a. ELECTRICITY AND MAGNETISM. (McRae)

This course is designed as an introduction to the study of electricity and magnetism.

Prerequisite: Mathematics 3a.

Elective, first semester, lectures and recitations, two hours per

week. Laboratory work, two afternoons per week. Credit four hours.

Text: Thompson, *Lessons in Electricity and Magnetism.*

11b. THEORY OF ELECTRICITY AND MAGNETISM. (McRae)

A mathematical treatment of the subject for graduates and undergraduates.

Prerequisite: Physics 3a.

Elective, first semester, three hours per week. Credit three hours.

13a. ALTERNATING CURRENTS. (McRae)

A continuation of Physics 7b and includes a rigorous analytical treatment of the subject as well as a study of the various practical applications in mining and metallurgy.

Prerequisites: Physics 7b and 8b.

Elective, first semester, three hours per week. Credit three hours.

15b. INTERNAL COMBUSTION ENGINES. (McRae)

This course includes the theory of internal combustion engines, as well as their practical application in mining operations and in metallurgical industries.

Prerequisites: Physics 5a and 6a.

Required in VII. and VIII.

Graduate course, second semester, three hours per week. Credit three hours.

SHOP PRACTICE AND DRAWING.

Assistant Professor Bowen, Mr. Buerstatte, Mr. Conover, Mr. Naylor.

Equipment.

The shops are thoroughly equipped with machinery and benches adapted to instruction. The wood bench work room contains twenty double benches with separate sets of hand tools. The lathe room is equipped with twenty Fay & Egan 12-in. swing college wood lathes and iron shears. The other machines in the lathe room include a Fay & Egan 27-in. planer, a Fay & Egan band saw with 30-in. wheels, an Oliver universal saw-table, two Oliver wood trimmers, a mortise machine, jig saw, grindstone, and other necessary tools.

For instruction in forge work there are twenty-four Buffalo Forge Company down-draft forges, power hammer, drill press, power shears, and grinder.

The metal-working room contains:

One 20-in. by 8-ft. Reed Lathe.
One 12-in. by 6-ft. Reed Lathe.
One 14-in. by 6-ft. Hendey Lathe.
One 14-in. by 6-ft. American Lathe.
One No. 2A Brown & Sharpe Universal Milling Machine
One Hendey 15-in. Pillar Shaper.
One Dwight Sensitive Drill.
One Barnes 22-in. Swing Upright Drill Press.
One 24-in. Morse Double Emery Grinder.
One 24-in. by 24-in. by 6-ft. Chandler Planer.
Two Greenard Arbor Presses, No. 3½ and No. 1.
One No. 1 Burr Cold Saw.
One 3-fire Chicago Flexible Shaft Gas Furnace.

All of the above mentioned iron-working machinery is of latest design and driven by individual motors. The benches in the lathe room have hardwood tops mounted on standard Brown & Sharpe bench legs. Twenty-four machinist vises, twelve of which have the swivel base and jaw, equip the shop for bench work.

The drawing rooms are equipped with double drawing tables and will accommodate two hundred and forty students working in two sections.

FORGE SHOP

Courses.

1a. DESCRIPTIVE GEOMETRY. *Lectures and Problems.*
(Buerstatte)

The usual text-book work is reinforced with daily blackboard exercises in presenting the projections of familiar objects, intersections of plane and curved surfaces, sections, developments, and shades and shadows. The afternoons in the drawing room are spent in solving in neat form more elaborate exercises.

Prerequisites: Entrance requirements.

Required in I., II., III., IV., V., and VI.

Freshman year, first semester, three hours per week. Credit three hours.

Text: Faunce, *Descriptive Geometry.*

2a. MECHANICAL DRAWING. *Laboratory.*
(Buerstatte, Conover)

The student is first given practice in geometrical construction until he is familiar with the nature, care and use of drafting instruments. Then, after carefully studying the principles of orthographic projection, intersection, and development, he is thoroughly drilled in free-hand lettering. The course is completed with one term of machine drawing. In this the student is required to make sketches, detail and assembly drawings of machines, and is taught the principles of elementary machine design.

Prerequisites: Entrance requirements.

Required in I., II., III., IV., V., and VI.

Freshman year, first semester, six hours per week. Credit two hours.

Texts: Anthony, *Mechanical Drawing.*
Wilson, *Free-Hand Lettering; Machine Drawing.*

2b. MECHANICAL DRAWING. *Laboratory.*
(Buerstatte, Conover)

A continuation of Shop Practice and Drawing 2a.

Prerequisites: Shop Practice and Drawing 1a and 2a.

Freshman year, second semester, six hours per week. Credit two hours.

4a. MACHINE DRAWING.* *Laboratory.* (Buerstatte)

This course is a continuation of the work in mechanical drawing of the Freshman year. It includes exercises covering gearing,

*Students in I., II., and III. are required to elect in the first semester of the Junior Year either Shop Practice and Drawing 4a or Shop Practice and Drawing 16a and 18a.

power transmission, mechanism, and the simpler machines used in mining, ore dressing, and metallurgy.

Prerequisite: Shop Practice and Drawing 2b.
Required in V.; Elective in I., II., and III.
First semester, six hours per week. Credit two hours.

4b. MACHINE DRAWING. *Laboratory.* (Buerstatte)

This course is a continuation of Shop Practice and Drawing 4a.

Prerequisite: Shop Practice and Drawing 4a.
Elective.
Sophomore year, second semester, six hours per week. Credit two hours.

12a. WOOD WORK. *Laboratory.* (Bowen, Naylor)

The work in the wood shop aims to train the student in the use of wood-working tools and machinery and to familiarize him with the properties of the common woods. All work is done from drawings.

Prerequisites: Entrance requirements.
Required in I., II., III., IV., V., and VI.
Freshman year, first semester, six hours per week. Credit two hours.

14b. FORGE WORK. *Laboratory.* (Bowen)

This course begins with simple exercises in drawing, upsetting, bending, twisting, punching, and welding. The work gradually becomes more difficult, such as making eye-bolts, chains, and tongs. Tool making is then begun by making screw-drivers, hammers, chisels, and a complete set of lathe tools to be used later in the machine shop. This work is fully illustrated by drawings and lectures on the subject, covering the properties of the different grades of iron and steel. The instructors make the student familiar with the best grade of steel to be used for any required purpose, and the correct shape and temper necessary for the best work in cutting iron, steel, brass, and stone. The final and most important part of this work is the testing of rock-drills of different makes, care being taken to preserve the results of the tests on different grades of steel used.

Prerequisite: Shop Practice and Drawing 12a.
Required in I., II., III., IV., V., and VI.
Freshman year, second semester, six hours per week. Credit two hours.

16a. FORGE WORK.* *Laboratory.* (Bowen)

This course is a continuation of Shop Practice and Drawing 14b.

Prerequisite: Shop Practice and Drawing 14b.

Elective in I., II., and III.

Junior year, first semester, six hours per week for eight weeks. Credit one hour.

18a. MACHINE SHOP.* *Laboratory.* (Bowen)

This course begins with chipping to a line, filing to a dimension, and scraping to a surface plate. Machine operation is then begun; the principles and uses of the drill-press, lathe, planer, shaper, and milling machine are taught by lectures followed by practical work at each machine. After a reasonable time, skill is attained in operating the various machines through a course of graded exercises. In this work use is made of the vernier, micrometer, thread-micrometer, and gear-tooth caliper. The degree of accuracy thus acquired enables the student to use eye and hand in unison, and is a lasting benefit in teaching exactness in statement and measurement.

Prerequisite: Shop Practice and Drawing 16a.

Elective in I., II., and III.

Junior year, first semester, six hours per week for nine weeks. Credit one hour.

---

*Students in I., II., and III. are required to elect in the first semester of the Junior Year either Shop Practice and Drawing 4a or Shop Practice and Drawing 16a and 18a.

EXCURSIONS.

The State of Missouri occupies an important place in the mining industry, leading in the production of lead, zinc, cobalt, nickel, barite, and tripoli. Many opportunities are offered students at the School of Mines and Metallurgy for keeping closely in touch with the mining industry of Missouri and adjoining States. There have been many important developments during the last few years in methods of mining, dressing, and smelting lead and zinc ores. The lead district of Southeast Missouri and the zinc district of Southwest Missouri offer numerous examples of up-to-date practice in mining and metallurgical engineering. The aggregate tonnage capacity of the concentrating plants of Missouri is greater than that of any other State of the Union. The importance of modern methods of ore dressing is everywhere recognized and the facilities offered by the School of Mines for investigation in ore dressing, together with the practice in concentrating plants which are visited, places the School of Mines and Metallurgy in the foremost rank in this important branch of mine engineering.

Required.

A. At the opening of the school year one week's field work in topography is required of all students in Curricula I., II., III., and V. This work is carried on in the vicinity of Rolla.

B. At the close of the Junior year all students in Curricula I., II., III., IV., and IX. make a three weeks' excursion to Southeast Missouri for practice in mine surveying and the study of field and economic geology, mining and ore dressing. Instead of B, students may elect Optional Trip 4.

C. During the Senior year a one week's trip to Southwest Missouri, particularly the Joplin District, for the study of ore deposits, mining methods, and ore dressing. Required in I., II., and III.

D. During the latter part of the Senior year trips to Steelville, Sligo, DeCamp, Meramec, Newburg, and Sullivan for the purpose of studying iron, copper, and lead deposits. Required in I., II., III., and IX.

E. At the close of the first semester of the Senior year a trip to Herculaneum, St. Louis, Granite City, Alton and the coal fields of Illinois. Required in I., II., III., IV., and IX.

Optional.

In addition to the foregoing trips which are required in the various courses, a number of optional excursions may be made under the supervision of the members of the Faculty. These excursions are planned for students who have finished the work of the Junior year and may be made to the following mining districts:

1. Southern Appalachian District, where geology, mining, and metallurgy may be studied, particularly in the mining districts of Birmingham, Ala., and Ducktown, Tenn.

2. Copper mining districts of the Southwest, particularly Bisbee, Ariz., and Cananea, Mexico.

3. Lake Superior mining district, including the copper and iron ranges of Michigan and the iron ranges of Minnesota.

4. Metal mining districts of Colorado and Utah.

These trips and excursions give the student an opportunity to study mining, ore dressing, and metallurgical practice. Field work in metal mine surveying is carried on in suitable mines conveniently located in Southeast or Southwest Missouri. The practice in coal mine surveying is given in one of the Northern Missouri coal mines or in the Illinois field.

The Junior class visits Southeast Missouri to study the geology, methods of mining, and the milling of great disseminated lead deposits. The geological work of the Junior trip is especially valuable because of the variety of work introduced. The class has an opportunity to study several varieties of pre-Cambrian rocks of igneous and other origin. Differentiation in magma and intrusions can be seen. The pre-Cambrian topography is discernible in relation to the contact plane between the pre-Cambrian and the Cambrian. Evidence of superimposed drainage is offered. Iron ores of Shepard Mountain, Pilot Knob, and Iron Mountain give interesting study in the distribution and origin of ores. The general relation of the lead ores of the Paleozoic is also studied. The weathering of various kinds of rock in conjunction with jointing and stratification is well illustrated. The Carboniferous basin about St. Louis is given a brief examination. The student should be provided with note-book, compass, clinometer, hammer, and magnifying glass. The observation work of the day is supplemented by evening conferences.

The concentrating plants of Southeast Missouri are large and modern, containing crushers, rolls, elevating machinery, Wilfley tables, Frue vanners, jigs, and sundry other machines. The mining plants are thoroughly modern and include steam and electric hoists,

modern steel head-frames, compressed air and electric haulage, extensive pumping plants, and numerous diamond-drill prospecting equipments.

In Southwest Missouri the geology, mining, and milling of the shallow deposits as well as of "sheet" ground are studied by the Seniors. Opportunity is given to inspect and study the various types of equipment and methods as adapted to shallow and deeper mining. Many new concentrating plants have been erected and are strictly modern in design and equipment. The application of electric power to mining and milling is well illustrated in this district. Short trips are made to neighboring camps in Southeastern Kansas.

During the summer of 1910, a section of the Junior class made a trip to Colorado and Utah, visiting Denver, Idaho Springs, Central City, Georgetown, Silver Plume, Montezuma, Breckenridge, Leadville, Colorado Springs, Cripple Creek, Victor, and Pueblo in Colorado, and Salt Lake City, Garfield, and Bingham in Utah. Work in mine surveying was done at Idaho Springs. Special attention was given to mining practice in the Clear Creek District, the Cripple Creek District, and Leadville and vicinity. Amalgamation was studied in the Clear Creek District; cyanidation at Colorado Springs and Victor; smelting of gold, silver, copper, and lead ores at Leadville and Pueblo; iron and steel metallurgy at Pueblo; treatment of zinc ores at Leadville.

Special attention is paid on these trips to general engineering problems, plant design, economy of operation, and organization.

During the Senior year several trips are made to the metallurgical plants in the vicinity of St. Louis. The plant of the St. Louis Blast Furnace Company illustrates blast-furnace practice. Here may be studied the blast-furnace, regenerative stoves, blowing machinery, power plant, and other appliances necessary for the production of pig iron. Open-hearth steel methods and the manufacture of steel castings is studied at the Scullin & Gallagher Works. This plant includes, in addition to the usual type of open-hearth furnace, Bessemer converters, cupolas, and gas-producers.

The metallurgy of zinc is studied at the Edgar Zinc Works at Carondelet, where the roasting of blende and distillation methods may be seen. The Federal Smelter, at Alton, is visited for the study of lead smelting. At this plant the lead blast-furnace, the Huntington-Heberlin roasting system, and the Scotch ore-hearths are carefully inspected. This plant also includes an extensive bag house. The manufacture of white-lead paint and of lead pipe is seen at the National Lead Works. A further study of lead smelting is made at Herculaneum, where blast-furnaces are served by Savelsberg pot roasters. At the various plants enumerated, particular attention is paid to the construction of furnaces, the operation of the plant, and the general organization and design.

The manufacture of refractory materials is carefully followed from the mine to the finished product at the plant of the Laclede-Christy Company. This plant is one of the largest clay manufacturing works in the world, and a metallurgist here has a splendid opportunity to investigate refractory products and materials used in the construction of furnaces, stacks, retorts, and crucibles.

These excursions are a required part of the Curricula as noted on page 37, and no substitutions are allowed. Every candidate for a degree must take the prescribed excursions as scheduled.

GENERAL INFORMATION.

STUDENT ORGANIZATIONS.

The following chapters of college fraternities exist at the School: Gamma Chi of Sigma Nu, Beta Alpha of Kappa Alpha, Beta Chi of Kappa Sigma, Alpha Kappa of Pi Kappa Alpha, and Missouri Beta of Tau Beta Pi.

The Young Men's Christian Association was organized in the College several years ago, and is growing rapidly. It stands for the best there is in college life and brings together those who believe that college men should develop well-rounded characters, physical, mental, and spiritual. During the opening days of the college, trains are met by Association members, who place themselves at the service of the new men, helping them to secure rooms and board and to matriculate. The Association occupies the second floor of the Mining Building, where all students are welcomed and regular meetings are held.

The School of Mines Orchestra is reputed, throughout South Central Missouri, as without equal, and furnishes music for all School entertainments, the Commencement Exercises, and gives concerts in near-by towns.

Other Student Organizations include the Glee Club, the Mandolin Club, the Mathematical Club, and the International Club.

The student body publishes a year-book called "The Rollamo." The purpose of this volume is to record the student activities and to present a review of college life at Rolla.

Student Council.

In order to promote various student enterprises and activities and to maintain a spirit of mutual confidence in the student body and the faculty, there exists in the School of Mines a "Student Council," composed of representatives from the four classes. A committee of the faculty meets with the "Student Council" at all regular meetings and acts in an advisory capacity.

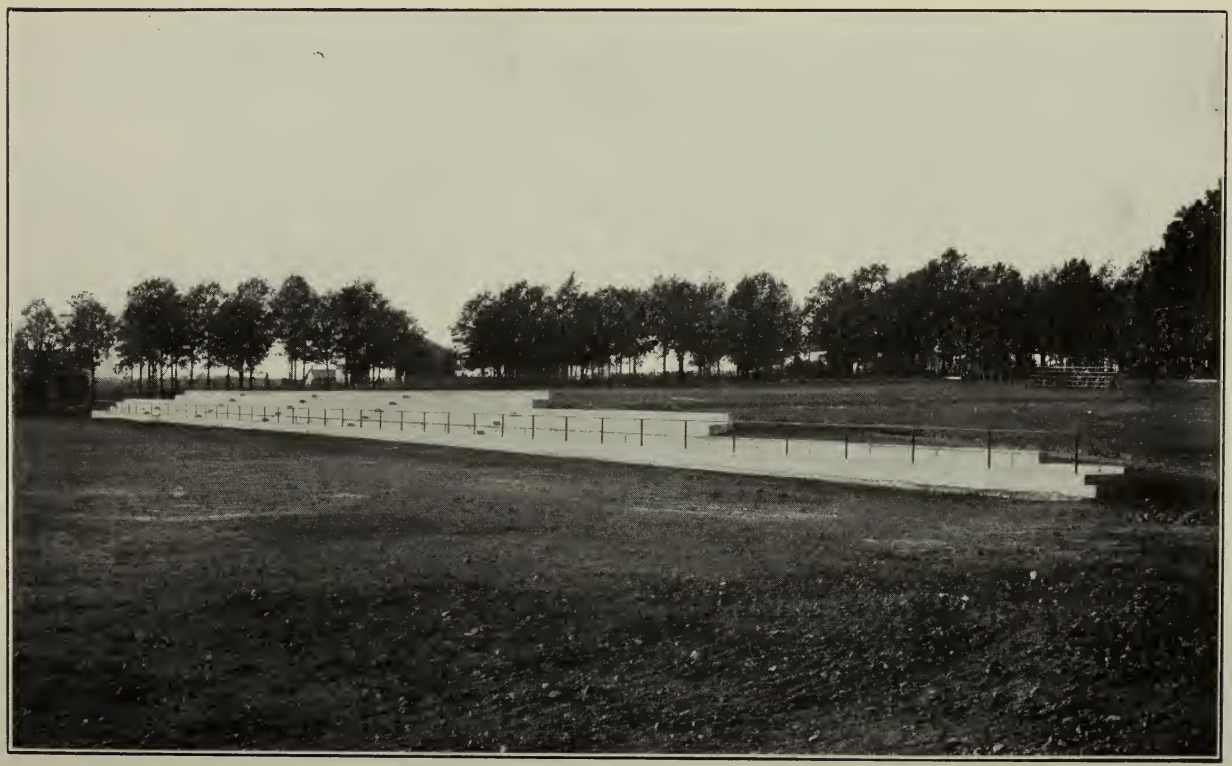
The representatives of the classes for 1910-1911 are:

Senior—D. L. Forrester, I. S. James, S. C. Macomber, R. B. Mitchell.

Junior—W. B. Gray, R. H. Maveety, W. Porri.

Sophomore—L. J. Boucher, E. R. Needles.

Freshman—L. Bowman.



VIEW ON JACKLING FIELD

The members of the Faculty Advisory Committee for 1910-1911 are:

Professor D. Copeland, Chairman.
Dr. A. L. McRae.
Professor G. H. Cox.
Professor C. R. Forbes.
Mr. F. E. Dennie.

ATHLETICS.

The School encourages rational athletics and has provided an instructor in physical training who has entire supervision of the physical training of students and of all intercollegiate sports. Occasional privileges are granted to athletic teams, but prolonged absences from work are not permitted.

The Jackling Field provides for baseball, football, and other games, and an ample number of tennis courts have been laid out and are maintained in good order. Suitable dressing-rooms and shower-baths are provided in a temporary building on the athletic field. A gymnasium is provided on the second floor of Mechanical Hall. Suitable gymnasium apparatus is supplied and indoor games can be carried on during the winter months. A general athletic association exists among the students.

School of Mines Athletic Association.

The purpose of the association is to unite the efforts of the School of Mines in athletic sports. The officers of the association, together with the Faculty Athletic Committee, have the management of the various athletic teams and supervise all intercollegiate athletic contests. The association maintains football, baseball, basketball, and track teams and encourages other games and sports.

All students are eligible to membership in the Athletic Association upon payment of an annual athletic fee of $5.00.

THE MISSOURI MINING ASSOCIATION.

The objects of the Mining Association are: To advance the knowledge of mining among its members; to promote good fellowship among the students and alumni of the School of Mines and others interested in mining, and to bring the School of Mines into closer relation with the mining profession at large. The membership consists of alumni and students in the School of Mines who have to their credit eighty-five semester hours.

The officers of the association are:

President ..... D. L. Forrester, 1911.
Vice-President ..... R. H. Maveety, 1912.
Secretary ..... J. S. Irwin, 1912.
Treasurer ..... R. A. Wagstaff, B. S., Drury College, 1910; M. S. M., 1912.

EXPENSES.

Tuition Fee.

Tuition is free to all students who are residents of Missouri. At a meeting held in October, 1908, the Board of Curators voted that "From and after January 1, 1909, non-residents of Missouri who matriculate in any Department of the University be required to pay a tuition fee of $20.00 per year."

Laboratory Fees.

The fees charged are as follows: An incidental and library fee of $5.00 a year, payable upon entrance; a laboratory fee in general chemistry to cover the cost of gas and supplies, $10.00 a semester; a laboratory fee in qualitative analysis of $10.00 a semester to cover the cost of general supplies and gas; a laboratory fee for quantitative analysis and Senior and Junior chemistry laboratory work, $2.00 a semester; a fee of $2.50 a semester to cover the cost of supplies for shop work; a fee of $2.50 a semester to cover the cost of fuel and supplies in forge work; a fee of $2.50 a semester to cover supplies in machine shop; a fee of $25.00 a semester to cover the cost of supplies and fuel in the assay laboratory; a fee of $5.00 a semester for metallurgy laboratory; a fee of $4.50 a semester for mineralogy laboratory; a fee of $2.50 for diploma.

Excursion Expenses.

The cost of field excursions will average about $35.00 a year. The total expenses of all trips in the four-year mining curriculum is about $140.00.

Contingent Deposits.

A deposit of $15.00 is required from each student to cover the cost of extra supplies and damage to apparatus. This deposit must be renewed if at any time exhausted, and at the end of the school year whatever sum may remain to the credit of the depositor is returned to him.

Annual Expense.

The expenses of many students for the entire year do not exceed $275.00, which amount will cover in a reasonable manner the fees, cost of books and stationery, board and lodging, and laundry. The cost of field excursions is not included in the above estimate.

FEES IN MINE ENGINEERING CURRICULUM.

FRESHMAN YEAR.

First Semester.

Matriculation	$ 5.00
Contingent Deposit*	15.00
Tuition (free for Missouri students)	10.00
General Chemistry Laboratory	10.00
Shop Work	2.50

Second Semester.

Tuition (free for Missouri students)	10.00
Qualitative Analysis Laboratory	10.00
Forge	2.50

SOPHOMORE YEAR.

First Semester.

Matriculation	5.00
Contingent Deposit*	15.00
Tuition (free for Missouri students)	10.00
Quantitative Analysis Laboratory	2.00
Mineralogy	4.50

Second Semester.

Tuition (free for Missouri students)	10.00
Quantitative Analysis Laboratory	2.00
Mineralogy	4.50

JUNIOR YEAR.

First Semester.

Matriculation	5.00
Contingent Deposit*	15.00
Tuition (free for Missouri students)	10.00
Forge and Machine Shop	2.50

Second Semester.

Tuition (free for Missouri students)	10.00
Assaying	25.00

*This is a deposit to cover extra supplies and breakage. An account is kept with each student and at the end of the school year whatever sum may remain to the credit of the depositor is returned to him.

SENIOR YEAR.

First Semester.

Matriculation	$ 5.00
Contingent Deposit*	15.00
Tuition (free for Missouri students)	10.00
Metallurgy Laboratory	5.00

Second Semester.

Tuition (free for Missouri students)	10.00
Diploma Fee	2.50

*This is a deposit to cover extra supplies and breakage. An account is kept with each student and at the end of the school year whatever sum may remain to the credit of the depositor is returned to him.

JACKLING LOAN FUND.

Loans may be made to students of the School of Mines from the Jackling Loan Fund under the following conditions:

1. The student must have been in attendance at the School of Mines one year.

2. Written requests for loans must be filed with the Director, to be considered at the following meeting of the Executive Committee.

3. Loans may be made to students who cannot give security provided they present the endorsement of the Director of the School and a responsible party not connected with the school.

4. No loans of more than one hundred dollars may be made to any one student during the calendar year.

5. Not more than two hundred dollars may be loaned to any one student.

6. The student shall give his note for the amount of the loan, which note shall bear interest at the rate of five per cent per annum from the date of the note to one year after his graduation or his leaving the School of Mines, and for the two years following at the rate of eight per cent per annum. The note shall then become due.

The purpose of the Jackling Loan Fund is to help worthy students who require financial assistance and who are unable to borrow money from other sources.

THE MINING EXPERIMENT STATION.

Officers of the Station.

ALBERT ROSS HILL, PH. D., LL. D...*President of the University.*
LEWIS EMANUEL YOUNG, E. M.....*Director, and Mining.*
DURWARD COPELAND, S. B.....*Metallurgy and Ore Dressing.*
VICTOR HUGO GOTTSCHALK, M. S...*Chemistry.*
GUY HENRY COX, M. A.....*Geology and Mineralogy.*
OLIVER WENDELL HOLMES, B. S....*Station Assistant.*

The Mining Experiment Station was established June 1, 1909.

It is the object of the station to conduct such original researches or to verify such experiments as relate to the properties and uses of mineral products; to investigate the engineering problems connected with the mineral industry, the economic methods of mining and the preparation of mineral products, the methods of preventing waste of the mineral resources and the methods of preventing accidents in mines, mills, and smelters; to assist in improving the conditions surrounding the labor in mines, mills, and smelters; and such other researches or experiments as bear directly upon the application of mining and of metallurgical engineering to the mineral industry of the State of Missouri.

The staff of the station is carrying on investigations on Missouri lead, zinc, and iron ores and on practical problems of interest to operators of coal and metal mines.

Bulletins published by the station are mailed free of charge to citizens of Missouri.

BUREAU OF GEOLOGY AND MINES.

The Geological Survey of the State of Missouri has its headquarters at Rolla, and occupies the Rolla Building on the school campus.

Board of Managers.

GOVERNOR HERBERT S. HADLEY, Jefferson City.
President.
HON. PHILIP N. MOORE, St. Louis.
Vice-President.
HON. S. DUFFIELD MITCHELL, Carthage.
Secretary.
HON. J. H. BOVARD, Kansas City.
HON. ELIAS S. GATCH, St. Louis.

Staff of the Geological Survey.

H. A. BUEHLER,
State Geologist.
G. W. CRANE,
Geologist.
V. H. HUGHES,
Geologist.
F. C. GREENE,
Geologist.
JOHN BODMAN,
Assistant Geologist.
WALLACE LEE,
Assistant Geologist.
A. X. ILLINSKI,
Chemist.

Equipment and Investigations.

The Geological Survey has at the present time a library of approximately five thousand volumes and pamphlets on geological and allied subjects and a museum of seven thousand specimens of clay, coal, barite, lead and zinc ore, iron ore, and other mine and quarry products of Missouri

The Geological Survey is organized principally to aid in the development of the mineral resources of Missouri. Information

concerning these resources is gathered through observations in the field by members of the staff. Geologic and topographic maps are prepared of different parts of the State and the various formations are accurately described in accompanying reports. The relation of the geology to the ore deposits is also worked out and detailed reports published concerning such investigations.

The Department has the following reports available for distribution at the present time:

Preliminary Report ..... Vol. XIII.
Geology of Miller County..... Vol. I., 2d series.
Quarrying Industry of Missouri..... Vol. II., 2d series.
Geology of Moniteau County..... Vol. III., 2d series.
Geology of the Granby Area..... Vol. IV., 2d series.
Public Roads ..... Vol. V., 2d series.
Lime and Cement Resources of Missouri..... Vol. VI., 2d series.
Geology of Morgan County..... Vol. VII., 2d series.
Geology of Pike County..... Vol. VIII., 2d series.
Geology of the Disseminated Lead Deposits of
St. Francois and Washington Counties..... Vol. IX., 2d series.

DEGREES CONFERRED 1910.

Engineer of Mines.

Albert Babbitt Bartlett, B. S., 1907.
Harry Carleton Chamberlain, B. S., 1905.
Lamar Horacio Hunt, B. S., 1905
Henry William Lohman, B. S., 1904.
George Edwin Lyman, B. S., 1902.

Horace Tharp Mann, B. S., 1908.
Norman Lloyd Ohnsorg, B. S., 1910.
Tsik Chan Tseung, B. S., 1907.
Edwin Richard Wash, B. S., 1907.

Metallurgical Engineer.

Walter Irving Phillips, B. S., 1907.
Andrew Jackson Seltzer, B. S., 1907.
Byron John Snyder, B. S., 1907.

Civil Engineer.

Robert Arthur Barton, B. S., 1906.

Master of Science.

Boyd Dudley, Jr., B. S., 1908.

Bachelor of Science (Mine Engineering).

Frank Orris Blake, Jr.
John Whittlesey Bodman.
Earl Frederick Boland.
William Grover Branham.
James Bunten.
Charles Adrian Burdick.
Russell Bigelow Caples, Jr.
Harry Wade Connelly.
Alfred Nicks Detweiler.
Emilio Diaz.
Ben. H. Dosenbach.
John Kavanaugh Forman.
Keith Colt Fraser.
Clay Gregory, Jr.
John Dee Harlan.
Oliver Wendell Holmes.
Ralph Daniel Killian.
Vachel Harry McNutt.

Robert William Mackey.
Harmon Edwin Minor.
Benton Franklin Murphy.
Norman Lloyd Ohnsorg.
John Lyle Pickering, Jr.
Louis Joseph Porri.
Harvey Edson Smith.
John Sloan Stewart, Jr.
Reuben Conrad Thompson.
Charles Weaver Traughber.
George C. Vogt.
Ernest Wander.

Bachelor of Science (Metallurgy).

Alexis Xavier Illinski.
Frederick Edward Riede.
Van Hoose Smith.

Bachelor of Science (Civil Engineering).

Frank Le Roy Flynt.
Albert Park.
Howard Kelsey Peterson.

Bachelor of Science (General Science).

James Joseph Bowles.
Walter Dobbins.
Theodore Saunders Dunn.
Elmer List.
Sidney Randolph Schmidt.
John Elmer Schultz.

MECHANICAL HALL

STUDENTS AT THE MISSOURI SCHOOL OF MINES AND METALLURGY.

1910-1911.

GRADUATE STUDENTS.

Benedict, Ralph Robert*.....*Kansas City, Mo.*
B. S. in M. E., 1908, School of Mines.

Boyer, George Hewitt*.....*St. Louis, Mo.*
B. S. in M. E., 1908, School of Mines.

Dennie, Frank Edward .....*Rolla, Mo.*
B. S. in C. E., 1909, Brown University.

Lintecum, Charles Lafayette*.....*Norfolk, Neb.*
B. S. in M. E., 1905, School of Mines.

McNutt, Vachel Harry.....*Rolla, Mo.*
B. S. in M. E., 1910, School of Mines.

Philippi, Paul Andrew*.....*St. Louis, Mo.*
B. S. in C. E., 1908, School of Mines.

Prugh, Julian Insco*.....*Cromberg, Cal.*
B. S. in M. E., 1905, School of Mines.

Thornhill, Edwin Bryant*.....*Salmon City, Idaho.*
B. S. in M. E., 1908, School of Mines.

Webster, Royal Sylvester*.....*Havana, Cuba.*
B. S. in C. E., 1903, School of Mines.

Wood, Clyde Rex*.....*Sheridan, Wyo.*
B. S. in M. E., 1908, School of Mines.

Wright, Ira Lee*.....*Leopold, N. Mex.*
B. S. in M. E., 1907, School of Mines.

*In Absentia.

SENIORS.

Abbott, Edward Rees.....*Rolla, Mo.*
Albertson, Maurice Merton.....*Aurora, Mo.*
Allen, Ernest James.....*Forrest, Ill.*
Beach, James Keller.....*Dallas, Tex.*
Bingham, Raymond Alexander.....*Rolla, Mo.*
Blake, True Walter.....*Chicago, Ill.*
Boza, Hector J.....*Lima, Peru*
Clark, John Charles.....*Rolla, Mo.*
Coaske, Paul Ephraim.....*St. Louis, Mo.*
Cody, Benjamin Horace.....*St. Joseph, Mo.*
Copeland, Robert Nathaniel.....*Rolla, Mo.*
Detweiler, Milan Harrison.....*Lebanon, Mo.*
Elmore, Carlos .....*Lima, Peru*
Englemann, Edward William.....*St. Louis, Mo.*
Flynn, Frank James.....*St. Joseph, Mo.*
Forrester, David Lawton.....*Rolla, Mo.*
Garcia, Germin .....*Mexico City, Mex.*
Hirdler, Eva Endurance.....*St. Louis, Mo.*
James, Ivory Small.....*Rolla, Mo.*
Karte, Anton Frederick.....*De Soto, Mo.*
Keelyn, James Lawton.....*Rolla, Mo.*
Kenney, John Richardson.....*Chicago, Ill.*
Kurz, Jacob Adolph.....*St. Louis, Mo.*
Lindau, Sam Paul.....*Liberty, Mo.*
Lunak, Otto Allen.....*Chicago, Ill.*
McFadden, Edwin Cook.....*Chicago, Ill.*
McGoughran, James Edward.....*Rolla, Mo.*
Macomber, Sumner Cooley.....*Des Moines, Iowa*
Miller, Christian R., Jr.....*Sedalia, Mo.*
Mitchell, Robert Bruce.....*Walker, Mo.*
Mook, Robert Lee.....*Rolla, Mo.*
Porth, Harry William Lee.....*Kansas City, Mo.*
Pudewa, Arthur Gustav.....*Chicago, Ill.*
Raj, Shiv.....*Lahore, India*
Randolph, Oscar Alan.....*Rolla, Mo.*
Schultz, John Elmer.....*Topeka, Kan.*
Smith, Duncan S.....*Rockford, Ill.*
Sprague, Roy Elliott.....*Farmington, Mich.*
Tedrow, Harvey Louis.....*St. Joseph, Mo.*
Townsend, Frank Edgar.....*Belgrade, Mo.*
Wagstaff, Richard Alexander.....*Springfield, Mo.*
Walker, John Perry, Jr.....*Rolla, Mo.*
Wilson, Thaddeus Constantine.....*Springfield, Mo.*
Winsor, Frank H., Jr.....*Mitchell, S. D.*

JUNIORS.

Abernathy, George Elmer.....*Willow Springs, Mo.*
Adams, Charles W., Jr.....*Mitchell, S. D.*
Adams, Henry Farnum.....*Prescott, Ariz.*
Andrus, Dexter Eli.....*Rockford, Ill.*
Bribach, Oscar Nicholas.....*St. Louis, Mo.*
Broughton, Eugene Harding.....*Jefferson City, Mo.*
Chase, James Howard.....*Logansport, Ind.*
Cockburn, Harold Wardell.....*St. Joseph, Mo.*
Conover, Cairy C.....*Carrollton, Mo.*
Conway, Clifford Leroy.....*Rolla, Mo.*
Coover, Louie Lincoln.....*Springfield, Mo.*
Copelin, Leonard Stephen.....*Great Falls, Mont.*
Cronk, Arthur Harrison.....*Omaha, Neb.*
Elbelt, William Henry.....*St. Joseph, Mo.*
Fogarty, Edmond Allen.....*Chinook, Mont.*
Ford, Harold Percy.....*St. Joseph, Mo.*
Geringer, Otto George.....*Chicago, Ill.*
Gleason, Augustus William.....*Chicago, Ill.*
Gray, Walter Berry.....*Louisiana, Mo.*
Grosberg, Alexander.....*St. Louis, Mo.*
Hackwood, Arthur Wellesley.....*Baxter Springs, Kan.*
Harris, Deane Dwight.....*Rolla, Mo.*
Hayes, Dale Irwin.....*Rock Island, Ill.*
Hellstrand, Gustaf Axel.....*Shanghai, China*
Hollister, Scovill Edward.....*Marshall, Mo.*
Hurtgen, John.....*Rolla, Mo.*
Irwin, Joseph Stewart.....*Louisiana, Mo.*
Katz, Edgar Douglas.....*Kissimmee, Fla.*
Katz, Howard M.....*Kissimmee, Fla.*
Kline, Duane Montgomery.....*Rolla, Mo.*
Knapenberger, William Ralph.....*Brunswick, Mo.*
Lynton, Edward Dale.....*Rolla, Mo.*
Lyons, Clyde Francis.....*Springfield, Mo.*
Maveety, Roswell Hall.....*Cincinnati, Ohio*
Miller, Winlock W., Jr.....*Kansas City, Mo.*
Molyneux, Guy Melvin.....*Rolla, Mo.*
Morris, Edwin Robinson.....*Jefferson City, Mo.*
Naylor, Arch Waugh.....*Rolla, Mo.*
Newell, John Crittenden.....*Terre Haute, Ind.*
Newton, Lloyd Charles.....*Gurdon, Ark.*
Paulette, Robert Justice.....*St. Joseph, Mo.*
Porri, William.....*St. Louis, Mo.*
Pratt, George H.....*Detroit, Mich.*
Radcliffe, Donald Newson.....*Rolla, Mo.*
Raible, Norman William.....*Hannibal, Mo.*

Sheffer, Mark.....*Rolla, Mo.*
Sherry, Homer Kent.....*Rolla, Mo.*
Stroup, Thomas Andrew.....*Quincy, Ill.*
Taggart, James Albert.....*Rolla, Mo.*
Thomas, George Sylvester.....*Chicago, Ill.*
Willmott, Miller Edward.....*Liberty, Mo.*
Wright, Clark Watson.....*St. Louis, Mo.*
Young, Carl Deuel.....*Fargo, N. D.*

SOPHOMORES.

Boucher, Leonidas James.....*Marshalltown, Iowa*
Bramson, Charles.....*Rolla, Mo.*
Brewer, William Francis.....*Carlinville, Ill.*
Brooks, Herbert.....*Sheridan, Wyo.*
Castillon, Tirso.....*Torreon, Mex.*
Cepeda, Miguel Leon.....*Mapimi, Mex.*
Clayton, Charles Yancey.....*Hannibal, Mo.*
Cody, Frank Wesley.....*St. Joseph, Mo.*
Croteau, Leon John.....*St. Joseph, Mo.*
Cummings, Lister Merriken.....*St. Louis, Mo.*
Cushwa, Claude.....*Independence, Mo.*
Dickson, Frank Paul, Jr.....*Kansas City, Mo.*
Donaldson, James Floyd.....*Kansas City, Mo.*
Ehlers, William, Jr.....*St. Louis, Mo.*
Garretson, Leona Belle.....*Rolla, Mo.*
Gelineau, Emilien Emerie.....*Rolla, Mo.*
Halley, Earl.....*Auxvasse, Mo.*
Hopkins, James.....*Ramey, Pa.*
Kadell, Carl Peter.....*St. Louis, Mo.*
Knickerbocker, Roy Gould.....*Clymers, Ind.*
Leasure, La Vere.....*Larned, Kan.*
McFarland, Russel Banta.....*Crawfordsville, Ind.*
McLure, Timothy Bloomfield Edgar.....*St. Louis, Mo.*
McNair, Stuart Strathy.....*Rolla, Mo.*
Marshall, Holman Thompson.....*Sioux City, Iowa*
Murphy, John Andrew.....*Mitchell, S. D.*
Needles, Enoch Ray.....*Rolla, Mo.*
Nowlan, Harry Hackett.....*Cheyenne, Wyo.*
Schmich, Matt, Jr.....*Freeport, Ill.*
Seward, J. Frederick.....*Hillsboro, Ill.*
Sickly, Robert Glenn.....*Iola, Kan.*
Smith, Clyde Othello.....*Rolla, Mo.*
Stricler, Dahl Lewis.....*Marion, Ind.*
Sudhoff, Ralph William.....*Richmond, Ind.*
Tiernan, James Pete.....*Kansas City, Mo.*
Ustick, Edward Thomas, Jr.....*St Louis, Mo.*

Webster, John Nixon.....*Creston, Iowa*
Wilson, Ernest C.....*Rolla, Mo.*

FRESHMEN.

Barclay, Hugh.....*Little Rock, Ark.*
Bogen, William Austin.....*St. Joseph, Mo.*
Bowman, Lee.....*Sikeston, Mo.*
Carlson, Anthony William.....*St. Louis, Mo.*
Collins, Lawrence.....*Quincy, Ill.*
Cowman, Gerard.....*Bellefontaine, Ohio*
Crutcher, Thomas Estus.....*Napton, Mo.*
Damotte, Edward Victor.....*Rolla, Mo.*
Davis, Fred E.....*Bevier, Mo.*
Edwards, Blaine.....*Lynn, Ind.*
Fahrendorf, Peter Maurice.....*Washington, Mo.*
Farrell, Oliver A.....*St. Louis, Mo.*
Genser, Joseph Dedeck.....*Gilliam, Mo.*
Goss, Blake.....*Rockville, Ind.*
Green, Carl D.....*Rolla, Mo.*
Halsey, Howard Gove.....*Kansas City, Mo.*
Hamm, Carl.....*Clifton, Ariz.*
Hammond, Arthur Kepler.....*Bonne Terre, Mo.*
Hatch, Sidney Raymond.....*George, Iowa*
Hubbard, Harold Jelleffe.....*Vincennes, Ind.*
Jones, Forrest Martin.....*Kansas City, Mo.*
Kayser, Alexander.....*St. Louis, Mo.*
Kelly, Mervin Joe.....*Gallatin, Mo.*
Kline, Harry Daniel.....*Rolla, Mo.*
Koch, Hugo Edward.....*Creve Coeur, Mo.*
Lodwick, Llewelyn.....*Ottumwa, Iowa*
Moses, Frederick Gallaway.....*Kansas City, Mo.*
Pringle, Lewis Braden.....*Quincy, Ill.*
Richards, Walter Harrison.....*La Moille, Iowa*
Ross, Charles Woodson.....*Springfield, Mo.*
Rule, Frank Jerald.....*Springfield, Mo.*
Schmidt, John Norman.....*Chicago, Ill.*
Stanley, Everett Rollins.....*Sedalia, Mo.*
Stroup, Jacob Carl.....*Quincy, Ill.*
Thomas, Rae.....*St. Louis, Mo.*
Wager, Walter Henry.....*Newtonia, Mo.*

SPECIAL STUDENTS.

Boyle, John Clarence.....*Trinidad, Colo.*
Hassett, James Lester.....*Rolla, Mo.*
Hielscher, J. A., M. D.....*Rolla, Mo.*
Hudson, Havard Farmer.....*Wichita, Kan.*
Maxwell, Arthur Byron.....*Chico, Tex.*
Updike, Maitland.....*Farmington, Mo.*

ALUMNI.

Alexander, Curtis, '84.....*Garfield, Utah*
Utah Copper Co.

Alexander, Raphael Currier, '03.....

Alexander, Thompson, '01.....*Chaffee, Mo.*
Division Engineer, Frisco R. R. Co.

Ambler, John Owen, '06.....*Box 188, Cananea, Son., Mex.*
Asst. Supt. Smelter, Cananea Consolidated Copper Co.

Anderson, Hector George Sylvester, '08.....*Kelvin, Ariz.*
Ray Consolidated Copper Co.

Anderson, Perry Barton, '97.....

Armstrong, Richard Edward, '08.....*Bingham, Utah*
Engineer, with Utah Consolidated Copper Co.

Baker, Arnold George, '07.....*P. O. Box 104, Chouteau, Mont.*
Baker & Ward, Irrigation Engineering.

Baker, Charles Armstrong, '08.....*Ely, Nev.*

Barker, Ralph, '98.....

Barrett, Edward Phillip, '09.....*Wilburton, Okla.*
Instructor in Chemistry, Oklahoma School of Mines.

Bartlett, Albert Babitt, '07.....*Cheyenne, Wyo.*
Consulting Mining Engineer.

Barton, Robert Arthur, '06.....*Vernon, B. C.*
Resident Engineer, Municipality of Coldstream.

Baueris, William Albert, '09.....*432 Central Bldg., Seattle, Wash.*
Asst. Engineer, Puget Sound Bridge and Dredging Co.

Bean, William Yantis, '78 .....*510 Pine St., St. Louis, Mo.*

Beard, John Warren, '09.....*Alma, N. Mex.*
Mine Engineer, Oaks Company.

Bedford, Robert Hardy, '06.....*Grass Valley, Cal.*

Bell, Frank Rolla, '03.....*Bartlesville, Okla.*
Asst. Supt., Bartlesville Zinc Co.

Benedict, Ralph Robert, '08.....*659 Park Ave., Kansas City, Mo.*
City Engineering Department.

Black, James Kenny, '04.....*Clayton, Mo.*
Instructor in Chemistry, Washington University.

Blake, Frank Orris, Jr., '10,
524 C. W. Hellman Bldg., Los Angeles, Cal.
Supt. of Refineries, El Oso Asphalt Co.

PETROGRAPHY LABORATORY

Bland, George Vest, '04.....*Sulzer, Alaska*
Acting General Manager, Alaska Industrial Co.

Bodman, John Whittlesey, '10.....*4412 Main St., Kansas City, Mo.*

Boland, Earl Frederick, '10.....*416 S. Crouse Ave., Syracuse, N. Y.*

Bowles, John Hyer, '08.....*Lake Springs, Mo.*

Bowles, James Joseph, '10.....*Lake Springs, Mo.*

Boyer, Fred Tete, '09.....*3633 Shenandoah Ave., St. Louis, Mo.*
Care of National Lead Company.

Boyer, George Hewitt, '08....*R. F. D. No. 8, Jefferson Barracks, Mo.*
Chemist, Continental Portland Cement Co.

Branham, William Grover, '10.....*Shannon Hill, Metcalf, Ariz.*
Shannon Copper Co.

Brooks, John McMillen, '06.....*Guanajuato, Guan., Mex.*
Aptd. 25, San Matias. Asst. to Supt., Mexican Milling and Transportation Company.

Brown, Joseph Jarvis, Jr., '05.....*Wilburton, Okla.*
Professor of Metallurgy, Oklahoma School of Mines.

Brown, William Ernest, '07.....

Brown, Wilton Rutherford, '78.....

Buckby, De Nard Wilson, '01.....*Great Falls, Mont.*
Boston-Montana Smelter.

Bunten, James, '10.....*Harding Block, Canon City, Colo.*
County Surveyor.
Bunten & Minor, Civil and Mining Engineers.

Burdick, Charles Adrian, '10.....*244 W. 3d St., New York, N. Y.*
Engineer, Timberlake Mining Co.

Burgher, Mark Bernardi, '06.....*Hannibal, Mo.*
City Engineer.

Buskett, Evans Walker, '95.....*Joplin, Mo.*

Buskett, Mary P., '93.....

Butler, Reginald Henry Brinton, '09,
"Kirbymead," Hermon Hill, South Woodford, Essex, England

Cameron, John Simpson, '97.....*Lehigh, Okla.*
Supt., Western Coal and Mining Company.

Caples, James Watts, '05.....*Salmon, Idaho*
Lemhi Engineering Co.

Caples, Russell Bigelow, Jr., '10.....*Anaconda, Mont.*

Carnahan, Thomas Samuel, '04.....*P. O. Box 296, Tonopah, Nev.*
General Manager, Tonopah-Liberty Mining Co.

Carson, Arthur C., '80.....*Butte, Mont.*
Manager, North Butte Copper Co.
Mine Supt., Speculation Mine Co.

Cavazos, Enrique, '09.....*Mazapil, Zacatecas, Mex.*
Mazapil Copper Co., Ltd.

Chamberlain, Ernest Lorenz, '09.....*St. Louis, Mo.*
Missouri-Pacific Engineering Department.

Chamberlain, Harry Carleton, '05.....*Gila Bend, Ariz.*

Chamberlain, Santiago, '00.....*P. O. Box 26, Monterey, Mex.*

Christopher, James Knight, '05,
317 Board of Trade Bldg., Kansas City, Mo.

Clark, George Clough, '99.....*Tucson, Ariz.*
Clark Engineering Company.

Clark, William Newton, '09.....*Ottumwa, Iowa*
Engineer, Phillips Fuel Co.

Clarke, William Danels, '09....*1911 Seventeenth St., Bakersfield, Cal.*

Clary, John Henry, '05.....*Wallace, Idaho*
Moore & Clary, Engineers and Assayers.

Claypool, William M., '84.....

Cole, George W., '87.....
Deceased.

Compton, James Crawford, '09,
623 Kansas Ave., Suite 3, Topeka, Kan.
Asphalt Chemist, Kaw Paving Co.

Connelly, Harry Wade, '10.....*Pluma, S. D.*
Care of Mogul Mining Co.

Conrads, Ralph Augustus, '04,
Apartado No. 8, El Oro, Mexico, D. F. Mex.
Asst. Manager Esperanza Mining Co.

Cook, Eldon Everett, '07.....*Osborn, Mo.*

Cook, Paul Richardson, '07..*518 Vermont Bldg., Salt Lake City, Utah*
Transitman, Oregon Short Line R. R.

Coppedge, Lindsay L., '78.....
Deceased.

Cowen, Herman Cyril, '95.....*Catskill, Greene Co., N. Y.*
Treasurer, Catskill Supply Company.

Cowles, Frederick Ragland, '01.....*300 E. 34th St., Kansas City, Mo.*
University Preparatory School.

Cowperthwaite, Thomas, '05.....*Box 794, Warren, Ariz.*
Engineer, Calumet and Arizona Mining Co.

Cullings, Jay, '86.....

Cummins, Robert Patrick, '05.....*3835 Page Ave., St. Louis, Mo.*
Engineering Department, Frisco R. R.

D'Arcy, Arthur Ignatius, '03.....*Mina, Nev.*

Daily, Cornelius Mark, '02.....*1200 Fullerton Bldg., St. Louis, Mo.*
Asst. Eng. and City Surveyor.

Davis, Floyd, '83.....*1659 Broadway, Denver. Colo.*
Consulting Mining Engineer.

Dean, George Reginald, '90.....*Rolla, Mo.*
Professor of Mathematics, Missouri School of Mines.

Dean, George Walter, '97.....*Apartado 86, Guaymao, Son., Mex.*
Gen'l Supt., Mexican-American Smelting and Refining Co.

Deegan, Francis J., '75.....
Deceased.

Delano, Lewis Alfred, '04.....*Bonne Terre, Mo.*
Milling Assayer, St. Joseph Lead Co.

De Lay, Theo. Stuart, '94.....*Creston, Iowa*
Civil and Municipal Engineer.

Detweiler, Alfred Hicks, '10.....*Altoona, Kan.*
Care of Altoona Zinc Co.

De Waters, Roy Haywood, '09.....*203 Pine St., St. Louis, Mo.*
Sec., Bishop-De Waters Mfg. Co.

Diaz, Emilio, '10,.....*Sta. Rosa 48, Santiago de Chile, Chile*

Dobbins, Walter, '10.....*Garfield, Utah*

Don, De Forrest, '09.....*Minas Pedrazzini, Arizpe, Son., Mex.*

Dosenbach, Ben. E., '10.....*Garfield, Utah*

Draper, James Clark, '01.....*Frisco Bldg., Joplin, Mo.*
Consulting Mining Engineer.

Dudley, Boyd, Jr., '08.....*Rolla, Mo.*
Instructor in Metallurgy and Ore Dressing, Missouri School of Mines.

Duncan, Gustavus A., '74.....*Nelson, Nev.*
Manager, Nevada Eldorado Mines Co.

Dunkin, Damon Duffield, 04.....*Wilburton, Okla.*
Professor of Mining, Oklahoma School of Mines.

Dunn, Theodore Saunders, '10.....*P. O. Box 133, Leopold, N. Mex.*
Savanna Copper Co.

Dwyer, Edward P., '95.....*110 E. Tenth St., Joplin, Mo.*
District Ore Purchasing Agent, Prime Western Spelter Co.

Dyer, T., '94.....*Rolla, Mo.*

Eardley, Albert Edwin, '97.....*Carrizo Springs, Tex.*
Contracting and Well Work.

Easley, George Albert, '09.....*Casilla 27a, La Paz, Bolivia, S. Amer.*
Supt., Olla de Ora Bolivian Gold Mining Co., Ltd.

Elicano, Victoriano.....*Massinloc, Tambles, P. I.*

Emerson, Cyrus, '76.....*Pittsburg, Kan.*

Ericson, John T. E., '07.....*1227 Caldwell St., Clairton, Pa.*
Chemist, with the Carnegie Steel Co.

Fach, Chas. Albert, '00.....*Kirkwood, Mo.*
Bonds and Stocks, Security Bldg., St. Louis, Mo.

Fellows, Aubrey P., '07.....*Collinsville, Ill.*
In charge of Sublimed Lead Plant.

Fernandez, Abraham Leonardo, '00.....*Monterey, Mex.*

Florreich, Phillip, '95.....*St. Louis, Mo.*
U. S. Engineering Corps.

Flynt, Frank Le Roy, '10.....*204 E. First St., Maryville, Mo.*
City Engineer.

Forman, John Kavanaugh, '10....*511 Keeler Ave., Bartlesville, Okla.*
Chemist, Lanyon-Starr Smelting Co.

Foster, Leo Joseph, '04.....*Montrose, Colo.*
Office Engineer, U. S. Reclamation Service.

Fowler, James Duncan, '08...*1014 Commerce Bldg., Kansas City, Mo.*
Locating Engineer, St. Louis-Kansas City Elect. R. R. Co.

Fraizer, Isaac Peter, '00.....*Rolla, Mo.*

Fraser, Keith Colt, '10.....*701 Keeler Ave., Bartlesville, Okla.*
Chemist, Lanyon-Starr Smelting Co.

French, Charles Lewis, '08.....*Bisbee, Ariz.*

Fulcher, James E., '86.....*3110 Bowman Ave., Highland Park, Iowa*
Professor of Civil Engineering, Highland Park College.

Gallagher, Phillip C., '84.....*226 West 9th St., Leadville, Colo.*
Chemist, Iron Silver Mining Co.

Garcia, John Adrian, '00.....*Old Colony Bldg., Chicago, Ill.*
General Superintendent, Brazil Block Coal Co.

Gardiner, William Alexander, '06.....*El Oro, Mex.*
Esperanza Mining Co.

Garrett, Leon Ellis, '01.....*Rolla, Mo.*
Asst. Professor of Mathematics, Missouri School of Mines.

Garst, Harvey Oden, '09.....*402 North Garfield, Pocatello, Idaho*
Instrument man, Oregon Short Line R. R. Co.

Garvens, Oscar E., '76.....*East St. Louis, Ill.*

Gibb, Frank W., '82.....*Little Rock, Ark.*
Gibb & Sanders, Architects.

Gill, John Holt, '74.....
Deceased.

Gill, William Harris, '03.....*Bartlesville, Okla.*
Supt., National Zinc Co.

Gormley, Samuel James, '95.....*Lima, Peru, S. Amer.*
Smelter Supt., Cerro de Pasco Mining Co.

Gottschalk, Victor Hugo, '98.....*Rolla, Mo.*
Professor of Chemistry, Missouri School of Mines.

Grabill, Lee R., '78....*Room 412 Municipal Bldg., Washington, D. C.*
Supt. of County Roads, District Columbia.

Greason, John D., '76.....
Deceased.

Green, Cecil Theodore, '06.....*Rosario, Sin., Mex.*
Care of Minas del Tajo.

Greenidge, Samuel Marshall, '02...*Apartado 344, Cananea, Son., Mex.*
Greenidge & Lee, Mining Engineers.

Gregory, Clay, Jr., '10.....*802 Wall St., Joplin, Mo.*
Cooke-Gregory Construction Co.

Gregory, James Albert, '05.....*Dallas, Tex.*

Grether, Walter Scott, '06.....*Rosiclare, Ill.*
Asst. Supt. of Cons., Rosiclare Lead and Fluorspar Co.

Griffith, William Thomas, '06.....*St. Louis, Mo.*

Grine, Harry Adam, '04,
419 Wright & Callender Bldg., Los Angeles, Cal.
General Supt., Gas Power Machinery Co.

Grove, Claude Devlin, '94.....*Marblemount, Wash.*
Skagit Queen Consolidated Mining Co.

Guntley, Edward Anthony, '06....*3726 S. Grand Ave., St. Louis, Mo.*

Hall, William Simpson, '09.....*Pachuca, Hdgo., Mex.*
Sampler, Real del Monte, Minas Barron.

Ham, Roscoe Conkling, '09.....*Tucson, Ariz.*
U. S. Deputy Surveyor.

Hand, Horace Alonzo, '06.....

Hanley, Herbert Russell, '01.....*Winthrop, Cal.*
Asst. Gen'l Mgr., Bully Hill Copper Mining and Smelting Co.

Hare, Almon W., '75.....*Box 381, 412 Hopkins Ave., Aspen, Colo.*
Chemist and Assayer.

Harlan, John Dee, '10.....*Parlin, Colo.*
Deerfield Mining Co.

Harper, Frank William, '08.....*Courtland, Ariz.*
Chief Chemist, Great Western Mining Co., and C. & A. Mining Company.

Harris, George W., '04.....*Guanjuato, Mex.*
Peregrina Mining and Milling Company.

Hartzell, Henry H., '06.....*Granby, Mo.*
Smelter Superintendent, Granby Milling and Smelting Co.

Hase, Herman Carl, '08.....*Smuggler, Colo.*
Tomboy Gold Mines Co., Ltd.

Hatch, William Peter, '07.....*Kansas City, Mo.*

Hatchett, Roger Hansom, '99,
Care of C. H. Jones, Rio Grande Bldg., El Paso, Tex.

Hauenstein, Frederick, '03.....*Tuscumbia, Mo.*

Heck, Elmer Cooper, '05.....*Hermosillo, Son., Mex.*
Verde Grande Copper Company.

Hendricks, James Otto, '99.....*Seligman, Mo.*

Herdman, George Walker, '94.....*Neosho Falls, Kan.*

Hinsch, Van Buren, '09.....*Wilburton, Okla.*
Instructor, Oklahoma School of Mines.

Hoffman, Ray Eugene, '05.....*Hannibal, Mo*
Supt. Mines and Quarries, Atlas Portland Cement Co.

Holmes, Oliver Wendell, '10.....*Rolla, Mo*
Station Assistant, Mining Experiment Station.

Horner, Preston King, '06,
Tanganyika Concession, Ltd., Katanga, Congo Free State, Africa

Hoyer, Rudolph C., '79.....*P. O. Box 763, Montgomery, Ala.*
Chief Draughtsman, U. S. Government.

Hughes, Victor Harmon, '09.....*Rolla, Mo.*
Geologist, with the Missouri Bureau of Geology and Mines.

Hunt, Lamar Horacio, '05..*Hacienda de Loreto, Pachuca, Hdgo., Mex.*
Mill Foreman.

Hynes, Dibrell Pryor, '08.....*Chicago, Ill.*
With the Dept. of Geology, University of Chicago, Ill.

Illinski, Alexis Xavier, '10.....*Rolla, Mo.*
Chemist, Missouri Bureau of Geology and Mines.

Jackling, Daniel C., '92.....*Salt Lake City, Utah*
General Manager, Utah Copper Co.
President, Ray Consolidated Copper Company.

Jochamowitz, Simon, '09.....*Box 683, Lima, Peru*
Engineer of the "Cuerpo de Minas," Peruvian Government.

Johnson, Edward Mackay, '92.....*Golden, Colo.*
Chemist, Golden Smelter.

Johnson, Horace Asahel, '08.....*Millers, Nev.*
Assayer and Chemist, Desert Power and Mill Co.

Jones, Elston Everett, '08.....

Jones, Fayette Alexander, '92, ..., ...
Room 4, Armijo Bldg., Albuquerque, N. Mex.
Consulting Mining Engineer and Geologist.

Kellogg, George Fred., '08.....*Fredericktown, Mo.*

Keniston, Carl Winthrop, '09.....*Box 42, Independence, Colo.*

Kersting, Felix John, '97.....*Columbia, Mo.*
State Highway Commission.

Kibe, Harry Clay, '09.....*Newburg, Mo.*
Superintendent, Newburg Mining and Milling Co.

Killian, Ralph Daniel, '10.....*Perryville, Mo.*

King, Charles Leclair, '04,
Cia. De Real Del Monte y Pachuca, Pachuca, Mex.

Kirkham, John Edward, '95.....*Ames, Iowa*
Associate Professor of Civil Engineering, Iowa State College.

Koeberlin, Frederick Richard, '01.....

Lachmund, Oscar, '86.....*Alamos, Son., Mex.*
Gen'l Mgr., Durazno Mines Co.

Laizure, Clyde McKeever, '05.....*Millers, Nev.*
Desert Power and Mill Co.

Lehman, John Ludwig Gustave, '09.....*Monett, Mo.*

Lintecum, Chas. Lafayette, '05.....

List, Elmer, '10.....*St. Francois, Mo.*

Logan, Louis Sublette, '03.....*408 N. 11th St., St. Joseph, Mo.*

Lohman, Harry William, '04.....*Breckenridge, Colo.*
Manager, Colorado Gold Dredging Co.

Long, James Carter, '07.....*Victor, Colo.*

Loveridge, Frank Richard, '09.....*6419 Virginia Ave., St. Louis, Mo.*
Chemist, with Continental Portland Cement Co.

Luther, Walter Adams, '03.....*St. James, Mo.*

Lyman, George Edwin, '02.....*Edwardsville, Ill.*
Chief Engineer, Madison Coal Corporation.

Lyneman, Felix Anthony, '08.....*Box 712, Denver, Colo.*

McCarthy, John Henry, Jr., '05...*6609 Florissant Ave., St. Louis, Mo.*

McCrae, Rowe Francis, '09.....*Hayden, Ariz.*

McElroy, William, '09.....*Ft. Scott, Kan.*
City Engineer.

McGrath, John E., '76.....*Washington, D. C.*
Coast and Geodetic Survey.

McNutt, Vachel Harry, '10.....*Rolla, Mo.*
Instructor in Mineralogy, Missouri School of Mines.

Mackey, Robert William, '10.....*Telluride, Colo.*
Asst. Engineer, Liberty Bell Gold Mining Co.

Mann, Horace Tharp, '08.....*Rolla, Mo.*
Instructor in Metallurgy, Missouri School of Mines.

Manwaring, Edgar George Ross, '05.....*Bisbee, Ariz.*

Mapes, Harold Thomas, '08,
San Sebastian Distro de Mascota, Jalisco, Mex.
Care of the Novidad Development Co.

Martin, Walter Guy, '96.....*Denver, Colo.*
Ore Purchasing Agent, United Zinc and Chemical Co.

Martinez, Carlos Efrin, '02.....*Saltillo, Coah., Mex.*
Saltillo Light Co.

Martinez, Juan G., '86.....

May, Lawrence, '02.....*1542 Union St., Schenectady, N. Y.*
Metallurgist, General Electric Company.

Mazany, Mark Stephen, '09.....*Garfield, Utah*
Converter Department, Garfield Plant, A. S. & R. Co.

Michael, Pearl Frederic, '09.....*Pocatello, Idaho*
Draughtsman, Oregon Short Line R. R. Co.

Millard, Sallie E., '91 (Mrs. Cornelius Roach)....*Jefferson City, Mo.*

Millsap, Thos. H., '77.....
Deceased.

Minger, Wm. C., '76.....*Idaho Springs, Colo.*
Assayer, Chamberlain-Dillingham Sampling Co.

Minor, Cyrus Edward, '04.....*Cananea, Mex.*
Cananea Consolidated Copper Co.

Minor, Harmon Edwin, '10.....*Harding Blk., Canon City, Colo.*
Bunten & Minor, Civil and Mining Engineers.

Mix, Ward Barr, '08.....*835 Troy Road, Edwardsville, Ill.*
Asst. Mining Engineer.

Moore, Frederick Arnold, '08.....*Herculaneum, Mo.*
Asst. Supt., St. Joe Lead Co.

Moore, Stanley Ralston, '05.....*Wallace, Idaho*
Moore & Clary, Engineers and Assayers.

Morgan, Glenn Beckley, '04.....*Federal Bldg., Duluth, Minn.*

Morris, Edmund James, '02.....
Deceased.

Mortland, Ernest Albert, '01.....*Hardin, Ill.*

Murphy, Benton Franklin, '10.....*Bonne Terre, Mo.*
Mine Surveyor, St. Joseph Lead Co.

Murray, Edwin Phelps, '08.....*Douglas Island, Alaska*
Treadwell Mine.

Nachtmann, Frank Xavier, '09.....*Joplin, Mo.*
Engineering Department, Frisco R. R.

Neer, Don Morgan, '08.....*Box 226, Lometa, Tex.*
Gulf, Colorado & Santa Fe R. R.

Nesbitt, William Corsey, '05.....*Colorado Springs, Colo.*

Neustraedter, Arthur, '84.....*Ocampo, Chihuahua, Mex.*
Manager, Compania Minera La Republica, S. A.

Norton, Benjamin Newton, '02.....*Douglas, Ariz.*
City Engineer and Building Inspector.

Nye, Alfred Leo, '08.....

Ohman-Dumesnil, A. H., '77.....*3553 Park Ave., St. Louis, Mo.*

Ohnsorg, Norman Lloyd, '10.....*2914 Ellsworth Ave., Berkeley, Cal.*

Olmsted, George Lewis, '01.....*Doe Run, Mo.*
Chemist, Doe Run Lead Co.

Owen, John R. D., '85.....
Deceased.

Pack, James, '77.....*De Lamar, Idaho*

Pack, John Wallace, '74.....*U. S. Mint, San Francisco, Cal.*
Asst. Assayer, U. S. Treasury Department.

Painter, William R., '82.....*Carrollton, Mo.*
Editor.

Park, Albert, '10.....*Care of Bartlett Eng. Co., Cheyenne, Wyo.*

Perkins, Edwin Thompson, '99.....*Granby, Mo.*
Underwood & Perkins, Mining and Metallurgical Engineers.

Perkins, Fred Hough, '99.....*Flagstaff, Ariz.*

Perkins, William Crutcher, '07.....*Plattsburg, Mo.*
U. S. Deputy Surveyor.

Peterson, Howard Kelsey, '10..*32 Franklin Ave., New Rochelle, N. Y.*

Phelps, Tracy Irwin, '06.....*Thistle, Utah*
Junior Engineer, U. S. Reclamation Service, Strawberry Valley Project.

Philippi, Paul Andrew, '08.....*5165 Maple Ave., St. Louis, Mo.*
Designer and Estimator, Unit Construction Co.

Phillips, Walter Irving, '07.....*Wheaton, Ill.*

Pickering, John Lyle, Jr., '10.....*Harrington, Ariz.*
Tiger Gold Mining Co.

Pickles, John Lewis, '02.....*Clifton, Ariz.*
Supt. and Chief Eng., Shannon, Ariz., Ry. Co.

Pollard, Arthur Lewis, '09.....*35 Bank St., Batavia, N. Y.*
Foreman Forge Shop, Johnston Harvester Co.

Porri, Louis Joseph.....*4304 N. 19th St., St. Louis, Mo.*

Powell, Frank Bowman, '06.....*Rolla, Mo.*
Lumber Merchant.

Powell, Walbridge Henry, '01.....*St. James, Mo.*
Lumber Merchant.

Price, Evan Edmund, '04..*407 Newhouse Bldg., Salt Lake City, Utah*
MacVichie & Price, Consulting Engineers.

Price, John Morgan, '04.....

Prugh, Julian Insco, '05.....*Cromberg, Cal.*
Supt., Grizzly Gold Mining Company.

Quinn, Matthew Vincent, '05.....*Quartzburg, Idaho*
Belshazzar Mining Company.

Reid, John Calum, '93.....*Lethbridge, Alberta, Can.*
General Manager, Chinook Coal Co., Ltd.

Rex, Harry Noel, '02.....*Douglas, Ariz.*

Rice, John Turner, '04.....*Box 452, Imperial, Cal.*
Supt., Imperial Water Co. and City Engineer.

Richards, Walter Coffran, 07.....*37 Gray Ave., Webster Groves, Mo.*

Riede, Frederick Edward, '10,
Care of Horse Head Inn, Palmerton, Pa.
Asst. Chief, Research Dept., New Jersey Zinc Co.

Rivera, Ramon, '06.....*Aranzazu No. 116, Guadalajara, Jalisco, Mex.*
Civil Engineer.

Roesler, Herbert Arno, '03.....*2726 Prospect Ave., Kansas City, Mo.*

Rogers, Herbert Fordyce, '99....*2914 Louisiana Ave., St. Louis, Mo.*

Rogers, John A., '03.....*Bland, N. Mex.*
Engineer, Cochite Gold Mining Co.

Rolufs, Rulof Theodore, '01.....*Herculaneum, Mo.*
Superintendent of the St. Joe Lead Co.

Ross, Beauregard, '82.....*Box 575, Victor, Colo.*
President and Manager, Victor-Cripple Creek Mining Co.

Rucker, Ray Fleming, '06.....*Newburg, Mo.*
Superintendent, Dana Mining Co.

Sandford, John Joseph, '08.....*Kellogg, Idaho*
Engineering Corps, Bunker Hill and Sullivan Mining Co.

Schmidt, Sidney Randolph, '10.....*Anaconda Club, Anaconda, Mont.*
Chemist, Washoe Smelter, Anaconda Copper Mining Co.

Schrantz, Ashnab B., '82.....

Schroeder, John Severin, '04.....*Peabody, Kan.*

Schultz, John Elmer, '10.....*Rolla, Mo.*

Schulze, Hermann Otto, '99.....*Wonder, via Fairview, Nev.*

Schulze, Eugene Victor, '03.....

Scott, John Bennett, '07.....*Rolla, Mo.*
Instructor in English, Missouri School of Mines.

Seamon, Frank Henry, '91.....*P. O. Box 97, El Paso, Tex.*
Commercial Chemist and Assayer.

Sebres, John Payne, '07.....*1607 South 40th St., Tacoma, Wash.*
Asst. Superintendent, Hurley-Mason Co.

Sedivy, Miles, '08.....*Garfield, Utah*
Utah Copper Company.

Seltzer, Andrew Jackson, '07..*407 E. 15th St., University Place, Neb.*
Professor of Chemistry, Nebraska Wesleyan University.

Shah, Aaron Max, '09.....*Vilna, Russia*

Shanks, John Dozier, '06.....*823 N. 3d St., St. Louis, Mo.*

Sheldon, Wilbur Elihu, '05.....*Moab, Utah*
Resident Engineer, Spanish Valley Water and Land Co.

Smith, Charles Dosh, '05.....*Webb City, Mo.*
Superintendent, Coahuila Mining Co.

Smith, Earl McColloch, '09,
Cape St. Gracias, Nicaragua, Central Amer.
Constancio Mine.

Smith, Harvey Edson, '10.....*Westville, Ill.*
Brazil Block Coal Co.

Smith, Lorin X.....*Houston, Mo.*

Smith, Van Hoose, '10.....*406 Broadway, Little Rock, Ark.*

Snyder, Byron John, '07.....*Dahlonega, Ga.*
Professor of Mining and Electrical Engineering, North Georgia Agricultural College.

Soest, Walter Ernest, '99.....*Chihuahua, Mex.*
Superintendent, Chihuahua Copper Co.

Spencer, Clifton Bates, '93.....*Joplin, Mo.*
Resident Engineer, St. L. & S. F. R. R.

Spengler, Albert, '01.....*2626 Holly St., Denver, Colo.*
General Supt., National Construction Co.

Stauber, Ignatius Joseph Henry, '01.....*Silver City, N. Mex.*
Superintendent Savanna Copper Co.

Steinmesch, Jesse Herman, '06.....*Desloge, Mo.*
Assistant Superintendent, Desloge Cons. Lead Co.

Stevens, John Vivian, '06.....*Los Lunas, N. Mex.*
Manager, Southwestern Irrigation, Land and Power Co.

Stewart, Arthur J., '91.....*Tecalitlan, Jalisco, Mex.*

Stewart, John Sloan, Jr., '10.....*Y. M. C. A. Bldg., Omaha, Neb.*
Asst. Assayer, Walter T. Page.

Summers, Edward B., '81.....*2618 Coliseum St., New Orleans, La.*
Government Engineer, Mississippi River Commission.

Sunada, Sakuhei, '07.....*143 Michigan Ave., Chicago, Ill.*

Taylor, Howard Joshua, '99.....*Abbingdon, Ill.*

Taylor, Joseph MacFerran, '05.....*Philadelphia, Pa.*

Tayman, Francis Joseph, '99.....*Los Grados, Guerrero, Mex.*
Mine Superintendent, Los Grados Incorporated.

Terrell, Arthur Davis, '98.....*De Pue, Ill.*
Superintendent Spelter Dept., Mineral Point Zinc Co.

Thomas, Alfred Augustus, Jr., '05.....*Springfield, Mo.*

Thomas, Wm. Stephens, '94.....*Bevier, Mo.*

Thompson, Robert Clair, '04.....*Wilburton, Okla.*
Professor of Chemistry, Oklahoma School of Mines.

Thompson, Reuben Conrad, '10.....*Garfield, Utah*

Thornhill, Edwin Bryant, '08.....*Salmon City, Idaho*
Lemhi Engineering Co.

Torrence, Euart Carl, '98.....*Pocahontas, Mo.*

Torrence, Leslie Clay, '97.....*Pocahontas, Mo.*

Traughber, Charles Weaver, '10.....*Calienta, Cal.*
Zenda Mining Co.

Tseung, Tsik Chan, '07.....*Changsha, Hunan, China*
Instructor, Polytechnic School.

Tweed, Walter James, '04.....*Houston, Mo.*

Tyrrell, Frank Lee, '92.....*Salem, Mo.*

Underwood, Jerrold Roscoe, '99.....*Granby, Mo.*
Underwood & Perkins, Mining and Metallurgical Engineers.

Van Devander, Hermann Neff, '82.....*Cedartown, Ga.*
City Engineer.

Van Frank, Phillip R., '85.....*Little Rock, Ark.*
Assistant Engineer, U. S. Government.

Vitt, John Thomas, '07.....*Salem, Ill.*
Asst. Engineer, C. & E. I. Ry.

Vogt, George C., '10.....*224 Harrison St., Davenport, Iowa*

Walker, John Edward, '03,
Room 702, E. P. & S. W. Bldg., El Paso, Tex.

Walsh, Francis Henry, '02.....*Guanajuato, Mex.*
Chief Electrical Engineer, Guanajuato Mining and Milling Co.

Wander, Ernest, '10.....*Montezuma, Colo.*
St. John's Mining Company.

Wash, Edwin Richard, '07.....*Box 147, Tombstone, Ariz.*
Mining Engineer.

Watkins, Joseph Clarence, '01.....*Joplin, Mo.*

Webster, Royal Sylvester, '03.....*Havana, Cuba*
Havana Central Railroad.

Weidner, Frank Hays, '03.....*Gas, Kan.*
Constructing Engineer, Prime Western Spelter Co.

Weigel, William Melvin, '00.....*State College, Pa.*
Associate Professor of Mining, Pennsylvania State College.

Wiles, George B., '87.....

Wilfley, Clifford Redman, '05.....*Hostotipaquillo, Jalisco, Mex.*
Cabrera Mines.

Wilson, Albert Dyke, '02.....*148 Rutger St., St. Louis, Mo.*
Chief Chemist, The Laclede Gas Light Co.

Wilson, Frank Lewis Leonard, '08.....*Omaha, Neb.*
Assistant Chief Chemist, American Smelting and Refining Co.

Wilson, Frank Walter, '84..*1126 Board of Trade Bldg., Boston, Mass.*
Consulting Engineer.

Wilson, Fremont, '85.....*Marion, Ind.*
Surveyor.

Winters, Chas. F., '79.....*Los Angeles, Cal.*
Teller, National Bank.

Wishon, A. Emory, '09.....*Fresno, Cal.*
San Joaquin Light and Power Co.

Wishon, Walter W., '81.....*Austin, Nev.*
Austin-Manhattan Consolidated Mining Co.

Wolf, Edgar Joseph, '09.....*1077 E. 34th St., Brooklyn, N. Y.*
Chemist, Dr. Chas. T. Hennig's Metallurgical and Chemical Testing Plant.

Wood, Clyde Rex, '08.....*Sheridan, Wyo.*
County Surveyor and Engineer.

Woodhall, Geo., Jr., '01.....*Denver, Colo.*

Woods, Clarence, '04.....*Tuolumne, Cal.*
Superintendent, Philbert Gold Mining Co.

Wright, Ira Lee, '07.....*Leopold, N. Mex.*
Savanna Copper Co.

Wyman, William Charles, '06.....*Ottumwa, Iowa*
Anchor Coal Co.

Yeater, Merritt W., '86.....*Sedalia, Mo.*
Contractor.

Zirulick, Hyman, '08.....*Minsk, Russia*

INDEX.

PRESS OF
LITTLE & BECKER PRINTING CO.,
ST. LOUIS, MO.